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GENERAL AMERICAN TRANSPORTATION CORPORATION

NATURAL VENTILATION TEST OF AN ABOVEGROUND FALLOUT SHELTER IN CHICAGO, ILLINOIS

by

R. H. Henninger
C. A. Madson

GARD Report 1268-81 August 1966

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This interim report describes environmental tests performed in a specific shelter. The discussion of the results is preliminary and should not be used as the basis for general conclusions. A subsequent final report will include a comparative evaluation of data from subsequent tests having a variety of configurations and locations.

GENERAL AMERICAN RESEARCH DIVISION

FOREWORD

The natural ventilation tests reported herein were conducted by General American Research Division of General American Transportation Corporation, Niles, Illinois, during the period of 12 July to 28 July 1965, under Stanford Research Institute (SRI) Contract No. B-64220(4949A-16)-US. Mr. C. A. Grubb of SRI monitored this Civil Defense project. The major objectives of this shelter ventilation test program are: "(a) to evaluate parameters that determine the resultant shelter environment, (b) to develop a rationale for estimating minimum shelter equipment requirements, and (c) to obtain and correlate experimental data in support of current or modified computational methods or for direct use as empirical information". These tests were confined exclusively to the evaluation of natural ventilation effects.

The authors wish to acknowledge the assistance provided by Mr. Walter Sterling, Housing Administrator and Mr. James Merutka, Superintendent of Fire Prevention and Safety for the University of Illinois, Medical Center Campus and also Mr. Philip Voegtle, Superintendent of Fire Prevention and Safety for the University of Illinois, Chicago Circle Campus. Through their efforts we were able to obtain the test site on the University's Medical Center Campus.

ABSTRACT

A 12-day natural ventilation test was conducted in a 275-occupant aboveground corridor-type shelter using wind forces only to supply ventilation air. This test is one in a series run to develop procedures to predict natural ventilation rates in aboveground shelters. An overall window ventilation efficiency (effectiveness factor) of 0.15 was determined experimentally with windows open on two walls. This effectiveness factor is independent of wind direction.

Based upon the experimentally determined effectiveness factor and a total openable window area of 119 square feet, the shelter will be adequately ventilated by natural ventilation 98.2 per cent of the days during the year. That is, in the Chicago area, the effective temperature of this shelter when occupied by 275 people at 10 square feet per person will not exceed 83°F for more than seven days during an average year.

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SECTION 1

INTRODUCTION

Ventilation tests of an aboveground corridor-type fallout shelter located in Chicago, Illinois, were performed during the month of July 1966 to determine air temperatures, humidities, and ventilation rates obtained using natural ventilation through existing windows and corridors. Shelter occupancy was simulated by the use of electromechanical devices (Simocs) which duplicate the sensible and latent metabolic output of shelter occupants.

Throughtout all tests, hourly data were recorded on wind speed and direction, ambient and shelter temperatures and humidities, and psychrometric conditions. The window ventilation efficiency was then determined.

SECTION 2

DESCRIPTION OF TEST SITE

The shelter tested was a portion of the fifth floor of the Student Residence Hall located in Chicago at the corner of Polk and Wolcott Streets on the Medical Center Campus of the University of Illinois (see Fig. 1). The test area consisted of the north and south wings of a T-shaped corridor and included 21 single and double bedrooms with individual closet space (see Figs. 2 and 3). A temporary plastic and plywood partition separated the test area from the rest of the fifth floor.

2.1 Occupancy Level

The total useable floor area of the north and south wings is 5200 square feet; however, only the corridor (800 feet square) and approximately half of each dormitory room (the half away from the windows) provides a protection factor of 40 or more (see Section 2.4) and therefore was considered to be occupied by shelterees during the test. Hence, the maximum occupied floor area was approximately 2750 square feet. At an occupancy loading of 10 square feet per person, the maximum number of occupants is 275.

2.2 Ventilation Openings

The only ventilation openings present in the shelter are 41 identical 50 inch by 39 inch double-hung windows (wooden sash type). Each of the 20 double bedrooms has two windows (see Fig. 4) while the single bedroom has only one window. Twenty-four windows are located in the east wall and 17 in the west wall of the shelter. Throughout the test, the upper sash of each window was closed. The bottom sash has a total openable area of 5.8 square feet.

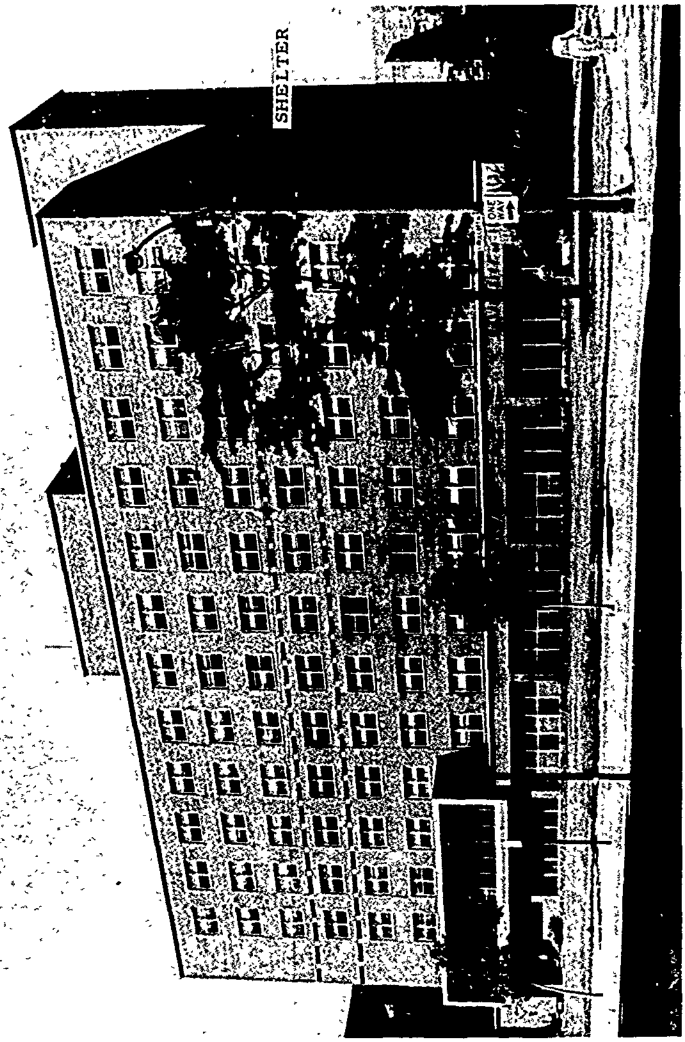


Figure 1 EXTERIOR VIEW OF STUDENT RESIDENCE HALL, CHICAGO, ILLINOIS

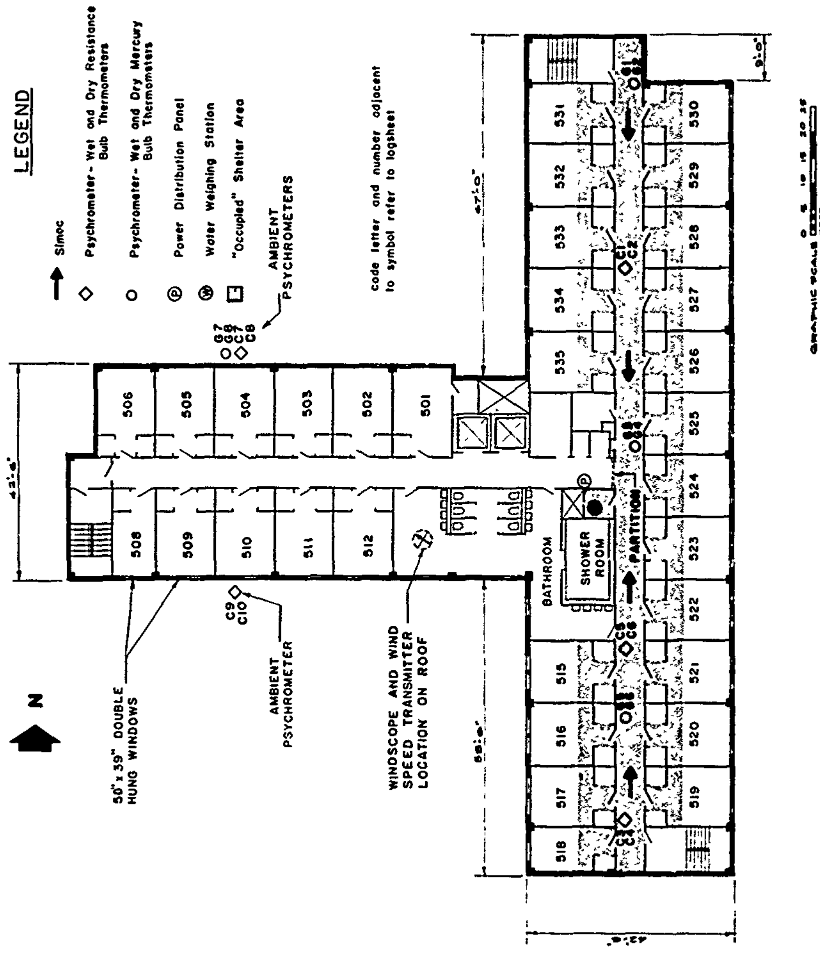


Figure 2 SHELTER FLOOR PLAN AND INSTRUMENTATION

Figure 3 TYPICAL DORMITORY ROOM

Figure 4 TYPICAL SHELTER WINDOWS

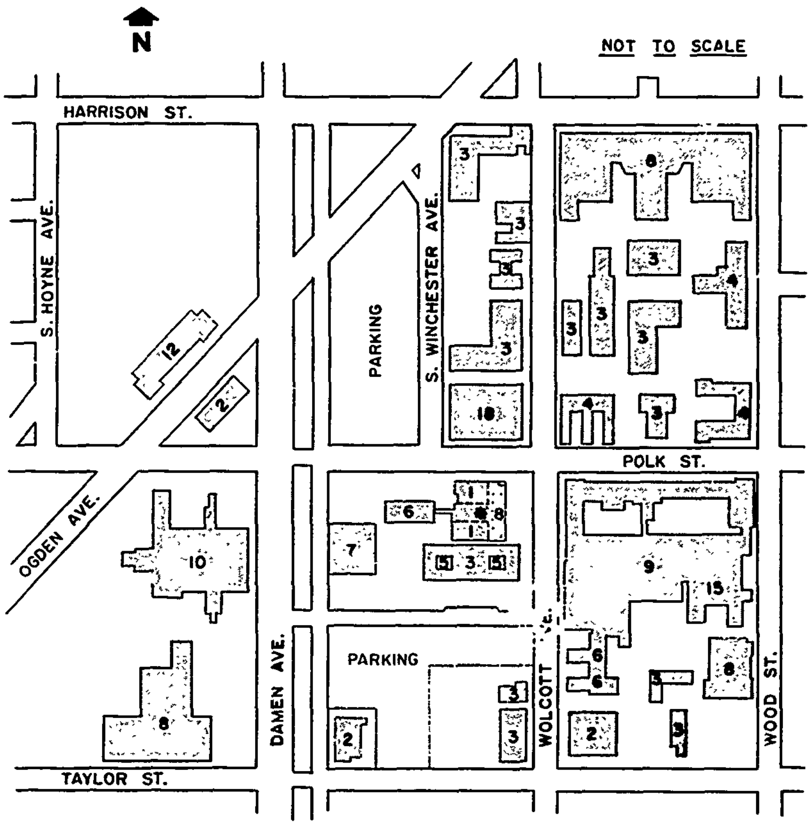
Although stairwells are present at both ends of the corridor, they could not be used as ventilation openings since the other floors in the building were occupied by students during the entire test.

2.3 Shelter Surroundings

Fig. 5 shows the locations and heights of buildings surrounding the shelter. An eighteen-story building (see Fig. 6a) lies directly opposite the shelter and approximately 110 feet away on the north side of Polk Street. Another large building, nine stories high, is located directly east of the shelter 190 feet away (see Fig. 6b). The nearest large buildings or obstructions south of the shelter are at least a block away (see Figs. 6c and 6d). West of the shelter is the east wing of the Student Residence Hall which divides the west wall of the shelter (see Fig. 7) and a six-story dormitory which lies 160 feet from the west wall of the shelter. All other structures within half a block of the shelter are of height and location such that they would have little effect on the wind conditions at the shelter windows.

2.4 Radiation Protection

An analysis of the shelter's radiation protection factor was made by Mr. W. B. Cobb, Registered Fallout Shelter Analyst (see Appendix A). Half of each dormitory room (the half away from the window) has a protection factor of 42 and therefore qualifies as shelter space. The corridor, providing better protection, has a protection factor of 110. This made 2750 square feet of floor area available for occupancy.



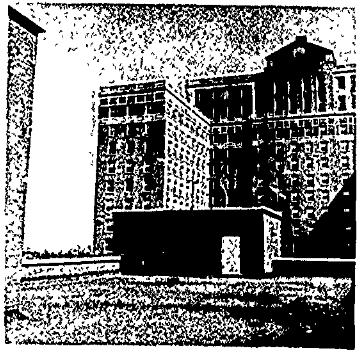
LEGEND

✱ WINDSCOPE AND WIND SPEED TRANSMITTER LOCATION ON ROOF

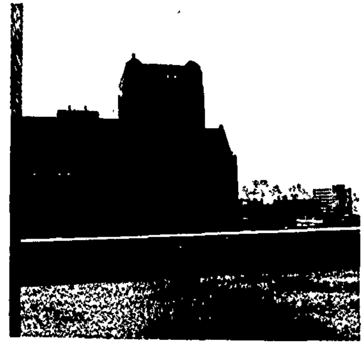
☐ SHELTER TEST SITE

☐ SURROUNDING BUILDINGS – Number Indicates Height in Stories

Figure 5 PLOT OF BUILDINGS SURROUNDING SHELTER

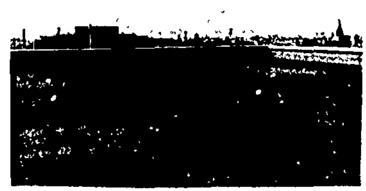


(a) North View



(b) East View

(c) Southeast View



(d) Southwest View

Figure 6 VIEW FROM ROOF OF STUDENT RESIDENCE HALL

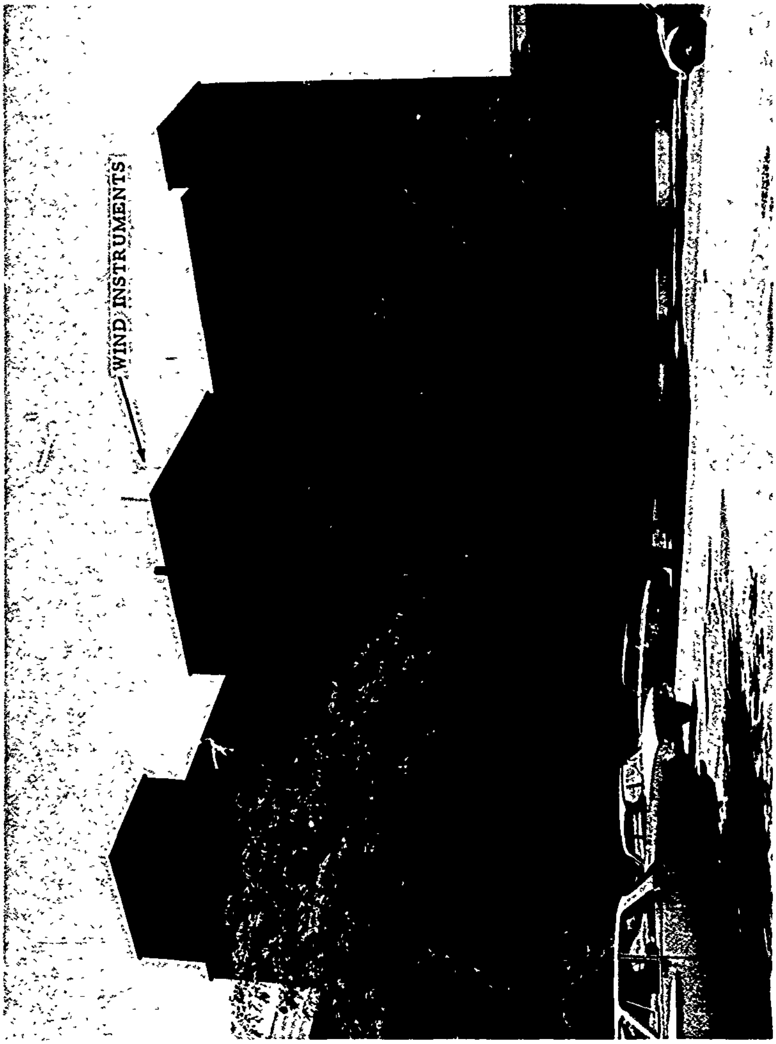


Figure 7 EXTERIOR VIEW OF NORTHWEST CORNER OF STUDENT RESIDENCE HALL

SECTION 3

INSTRUMENTATION

3.1 Temperature Measurement

Shelter and ambient dry-bulb and wet-bulb temperatures were measured with nine aspirating psychrometers (Sargent Model S-42610), five of which were equipped with resistance type thermometers (Minco #1119) and the remaining four equipped with mercury-bulb glass thermometers. Three of each type were located within the shelter four feet above the floor (see Fig. 8), and the remaining three psychrometers were positioned outside windows of rooms 504 and 510 to measure ambient weather conditions (see Fig. 2). All resistance bulb readings were recorded continuously on a Honeywell strip-chart multi-point recorder.

3.2 Shelter Energy and Moisture Inputs

Aggregate Simocs* (Ref. 1) were used to simulate the sensible and latent metabolic output of shelter occupants. Four Simocs were located along the corridor (Figs. 2 and 9) and adjusted to simulate uniform shelter loading of either 100 occupants or 185+ occupants.

The total occupant energy input to the shelter was measured each hour with a kilowatt-hour meter (Sangamo Model #P30DS, Class 200). This power input was adjusted, as required by line voltage variation, to maintain 400 Btu per occupant-hour.

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*Simulated Occupants

+Maximum number of occupants that could be simulated due to limited electrical power.

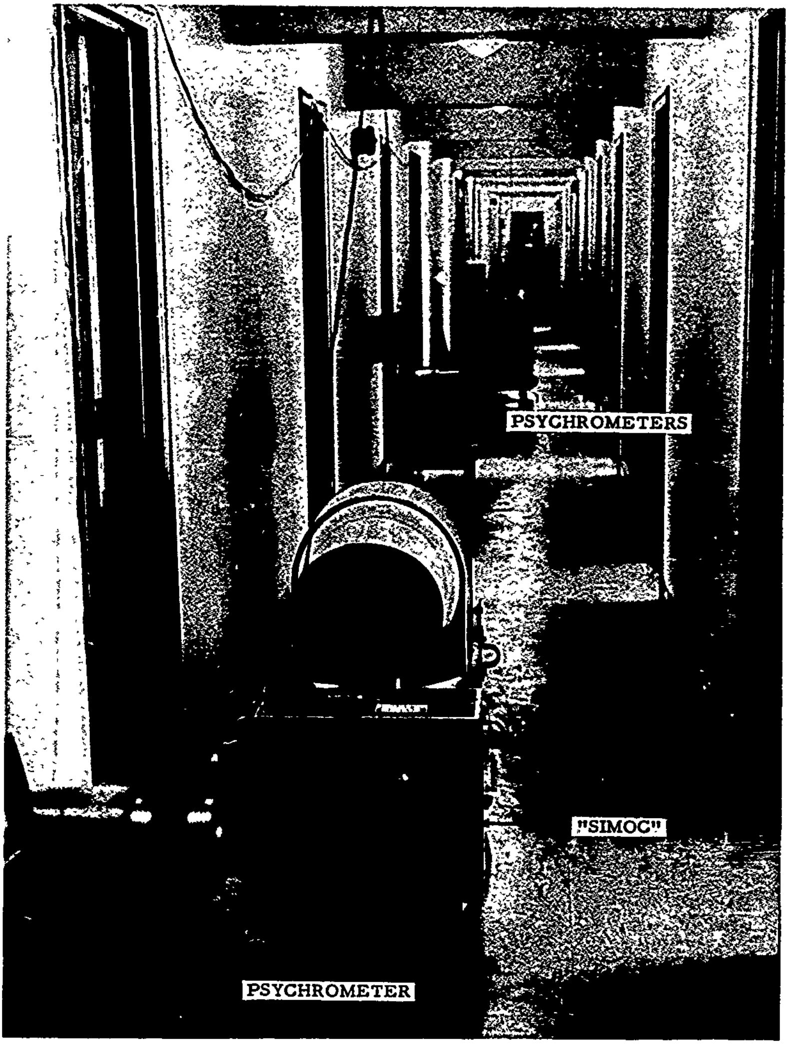
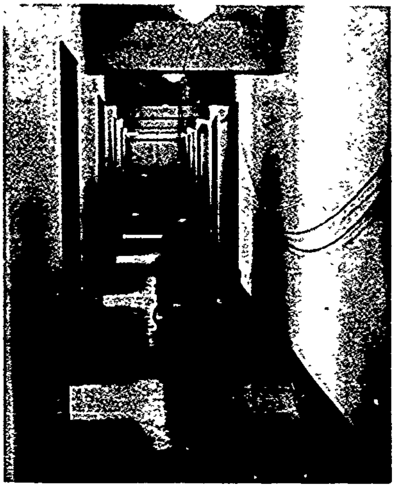
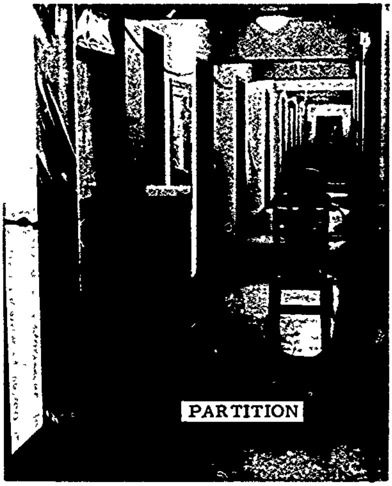


Figure 8 INTERIOR VIEW OF SHELTER CORRIDOR
LOOKING FROM SOUTH TO NORTH



Looking South From
Center of Corridor



Looking North From
Center of Corridor

Figure 9 OTHER INTERIOR VIEWS OF SHELTER CORRIDOR

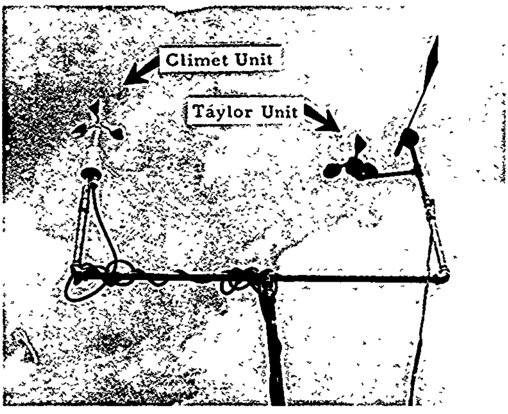


Figure 10 WIND INSTRUMENTS

During the entire test the shelter lighting and instrumentation loads were constant at 4780 Btu per hour.

The rate at which water (latent energy input) was discharged by the Simocs was measured hourly on a balance-beam platform scale. This rate was compared to the computed rate for 100 or 185 occupants, and the Simocs were adjusted as necessary to maintain the desired rate.

3.3 Wind Speed and Direction

Wind instruments (see Fig. 10) were placed on the penthouse roof which is about 95 feet above ground level. The instrument stand extended another 20 feet into the air which enabled readings of wind speed and direction to be measured at an elevation of 115 feet above ground level.

A Taylor Windscope (Model 3105) and a Climet Wind Speed Transmitter (Model 011-1) were placed atop the instrument stand. The Taylor Windscope gives instantaneous readings of wind speed and direction on a meter. The Climet Wind Speed Transmitter records an integrated time average wind speed on a digital counter.

SECTION 4

PROCEDURES

The eight tests that were conducted evaluated the effects of natural ventilation. These tests are summarized in Table 1.

4.1 Data Recording

The shelter and ambient air dry-bulb and wet-bulb temperatures and water input to the Simocs were logged hourly. The total Simoc power was also recorded each hour from the kilowatt meter. Every hour the average wind speed and direction were recorded during a one minute observation; in addition, an hourly integrated value of the wind speed was recorded with the Climet Wind Speed Transmitter.

From the U.S. Weather Bureau at Midway Airport, 7.6 miles southwest of the shelter, hourly conditions of the wind speed and direction were obtained and compared to the observations at the shelter site.

Psychrometric air properties were determined from the shelter average dry and wet-bulb temperatures using the ASHRAE Psychrometric Chart No. 1 (Ref. 2). Effective temperatures and humidity ratios were determined from tables developed by GARD (see Appendix B).

4.2 Determination of Ventilation Rate

The natural ventilation rate was calculated by the steady-state tracer gas technique using water vapor as the tracer gas (Ref. 3). The increase in shelter humidity ratio over ambient humidity ratio is related to the average

Table 1

Summary of Shelter Tests

TEST NUMBER	LOGSHEET NUMBER (S) (see Appendix C)	DATE (S)	TEST DURATION (HOURS)	NUMBER OF OCCUPANTS	"OCCUPIED" SHELTER AREA	VENTILATION OPENINGS **
1	1, 2	7/12 to 7/14	48	100	Corridor only	All 41 windows open 3 inches
2	3	7/14 to 7/15	24	100	"	All 41 windows open 6 inches
3	4, 5, 6	7/17 to 7/19	50	100	"	4 windows on NW wall (rms. 531 & 532) open 21.5 inches 4 windows on SE wall (rms. 519 & 520) open 21.5 inches
4	6, 7, 8	7/19 to 7/21	50	185	Corridor and approximately half the area of each room	All 41 windows open 3 inches
5	9, 10	7/21 to 7/23	48	185	"	All 41 windows open 6 inches
6	11, 12	7/25 to 7/27	48	185	"	2 windows on NW wall (rms. 531 & 534) open 21.5 inches, 1 window on SW wall (rm. 516) open 21.5 inches, and 3 windows on East wall (rms. 521, 524, & 528) open 21.5 inches
7	13	7/27	12	185	"	3 windows on NW wall (rms. 531, 533, & 535) open 21.5 inches, 2 windows on SW wall (rms 515 & 517) open 21.5 inches, and 5 windows on East wall (rms. 520, 522, 524, 527, & 529) open 21.5 inches
8	14	7/27 to 7/28	16	185	"	One window in each of twenty-one rooms open 21.5 inches

** Dimension given is the height to which bottom sash is raised above sill

shelter ventilation rate in accordance with the following equation:

$$Q = \frac{(v_o)(M_w)}{60(W_s - W_o)} \qquad (1)$$

where:

Q = ventilation rate, cfm

v_o = specific volume of ambient air, ft^3/lb d.a.

M_w = mass of water vapor supplied to shelter by Simocs, lb_w/hr

W_s = humidity ratio of shelter air, lb_w/lb d.a.

W_o = humidity ratio of ambient air, lb_w/lb d.a.

Equation 1 assumes:

1. construction materials impervious to water vapor,
2. no water vapor diffusion through open windows,
3. no moisture storage or release from the volume of the shelter air, and
4. no condensation of liquid water within the shelter.

The error introduced by the first and second assumptions is small when using the steady-state technique. The third assumption could introduce a considerable error when considered on an hourly basis; however, over a period of several hours or more, this error becomes insignificant. The fourth assumption was valid for the entire testing period.

SECTION 5

TEST RESULTS AND DISCUSSION

Natural ventilation moves air through buildings without the help of mechanical equipment. The forces of wind pressure and density (thermal) differences provide the necessary motive forces to move air through ventilation openings and into and through buildings.

Thermal forces are produced when sensible heat and water vapor are added to a volume of air causing it to become less dense, rise and displace denser air. In tall buildings where stairwells, elevator shafts and other ventilation openings provide paths for vertical movement of air, ventilation rates due to thermal forces can be significant. In this test, however, all stairwells and elevator shafts were closed to prevent any air movement due to thermal forces (see Section 2.2).

Since thermally motivated forces were excluded during the testing period, it was expected that the air forced through the shelter was due to wind effects alone. The quantity of air forced through a window or ventilation opening may be predicted by the equation (Ref. 4):

$$Q_w = EAV \qquad (2)$$

where:

Q_w = air flow, cubic feet per minute

A = free area of inlets or outlets (assumed equal), square feet

V = wind velocity, feet per minute

E = effectiveness of openings (suggested values range from 0.25 to 0.60 depending upon the direction of the wind on the shelter)

Corrections are presented in the ASHRAE Guide and Data Book for the effect of unequal inlet and outlet areas. This correction (F), expressed as a multiplier of (EAV) and which is always $\geq$ 1.0, represents the increase in air flow above that which results for equal inlet and outlet areas (F = 1.0).

The prime objective of the data analysis is to establish a window effectiveness factor (E) for a corridor-type shelter. At first glance it might appear that E is a function of only the angle at which the air approaches the opening, and for the most part this is true; however, other influences such as the type of ventilation opening, the internal configuration of the shelter, the exterior shelter surroundings and the density of occupancy loading can all have an effect on the value of E. To separate these effects is a complex task.

To empirically determine the opening effectiveness, E in equation 2, the data was grouped according to wind direction. These data groupings were then plotted as ventilation rate per square foot of window area versus wind velocity. With the inclusion of appropriate constants, the slope of the least-squares curve fit to the data then represents the window effectiveness factor E.

5.1 Directionally Dependent E-Factor

Previous investigations (Refs. 5 to 8) have indicated that the window effectiveness factor is a function of the angle at which air approaches a ventilation opening. To further evaluate this effect the data was grouped into 16 wind direction intervals. These intervals included the 45° over-

lapping wind sectors of

NNW-N-NNE	SSE-S-SSW
NNE-NE-ENE	SSW-SW-WSW
ENE-E-ESE	WSW-W-WNW
ESE-SE-SSE	WNW-NW-NNW

and the 90° overlapping wind sectors of

NW-N-NE	SE-S-SW
N-NE-E	S-SW-W
NE-E-SE	SW-W-NW
E-SE-S	W-NW-N

The data points included in each of these sixteen wind direction intervals were then fit with a linear least squares curve (linear because equation 2 indicates that Q should be a linear function of V). Figs. 11 to 18 depict the least squares curve fit for the 90° sectors and present the effectiveness factor which was determined by the slope of the curve.

Table 2 summarizes numerically the results for the sixteen intervals for an assumed equal inlet-outlet window pattern (F = 1.0) and for various limits of experimental error as determined in Section 5.4. As the value of $\left[W_s - W_o\right]$ is decreased, the maximum possible experimental error increases. Hence, the results listed in Table 2 for $\left[W_s - W_o\right] \geq 0.00200$ have the least possible experimental error.

Based upon the data collected during the limited testing period, it appears that the 90° wind sector results give a truer indication of the E-factor than the results for the 45° wind sectors. This conclusion is based upon two observations: first, the range of E for the 90° sectors is in closer agreement with the physical conditions which actually surround the shelter and second, too few data points are available for certain sectors of the 45°

analysis to put much faith in their results. Subsequent analysis is therefore based upon the values of E obtained with the 90° wind sector analysis for $\left[W_s - W_o\right] \geq 0.00200$.

Table 3 summarizes the same data groupings as were used in Table 2, using, however, the actual inlet-outlet window pattern which existed during the test as determined by hourly observations. Comparison of the two tables show that the experimental values of E remain almost the same for the results with $\left[W_s - W_o\right] \geq 0.00200$. This indicates that the open window area was split evenly between inlets and outlets during most of the testing period.

5.2 Overall E-Factor

During any designated time period (whether it be for a day, week, month or year), the wind direction does not remain constant, therefore, the calculation of average ventilation rates based upon the directional E-factors would have little value. An overall or average E which is independent of wind direction would have more applicability.

An overall E-factor of 0.15 was calculated for this shelter with a least squares analysis similar to that discussed previously. The overall E was determined by a least squares fit of all data points from all wind directions with a value of $\left[W_s - W_o\right] \geq 0.00200$ (see Fig. 19).

5.3 Comparison of Local and Weather Bureau Data

Local wind speed and direction data were obtained from the U.S. Weather Bureau located at Midway Airport which is 7.6 miles southwest of the shelter. In addition, observations of wind speed and direction were made at the shelter

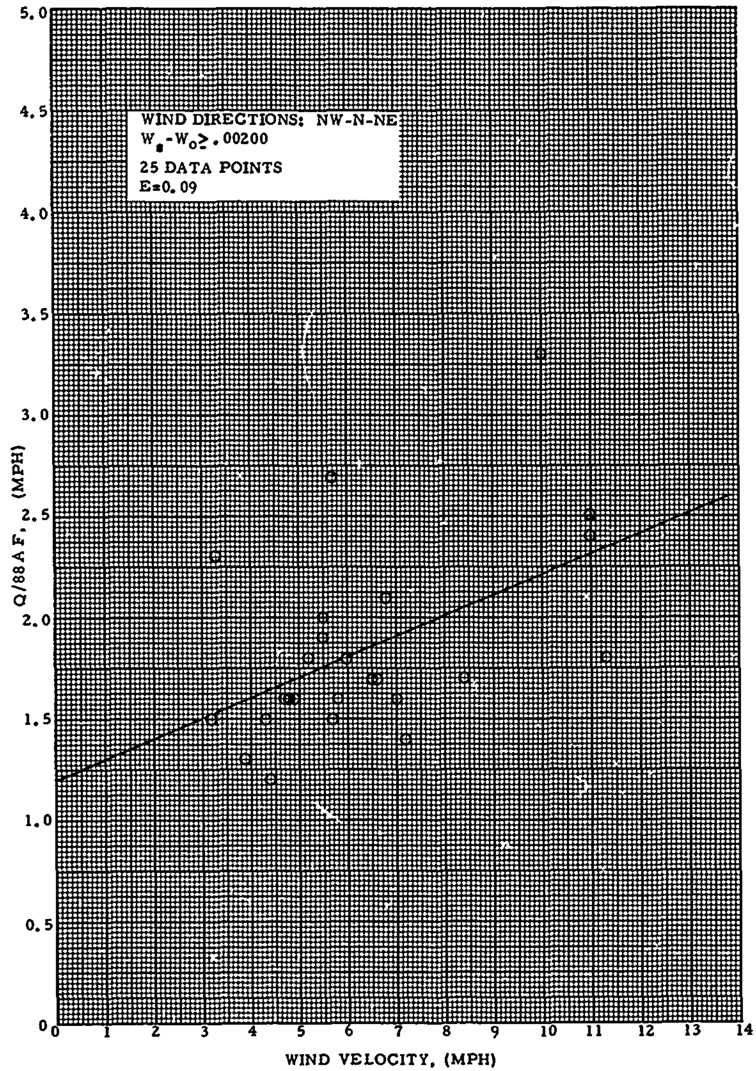


Figure 11 CORRELATION OF DATA FOR NW-N-NE WIND SECTOR

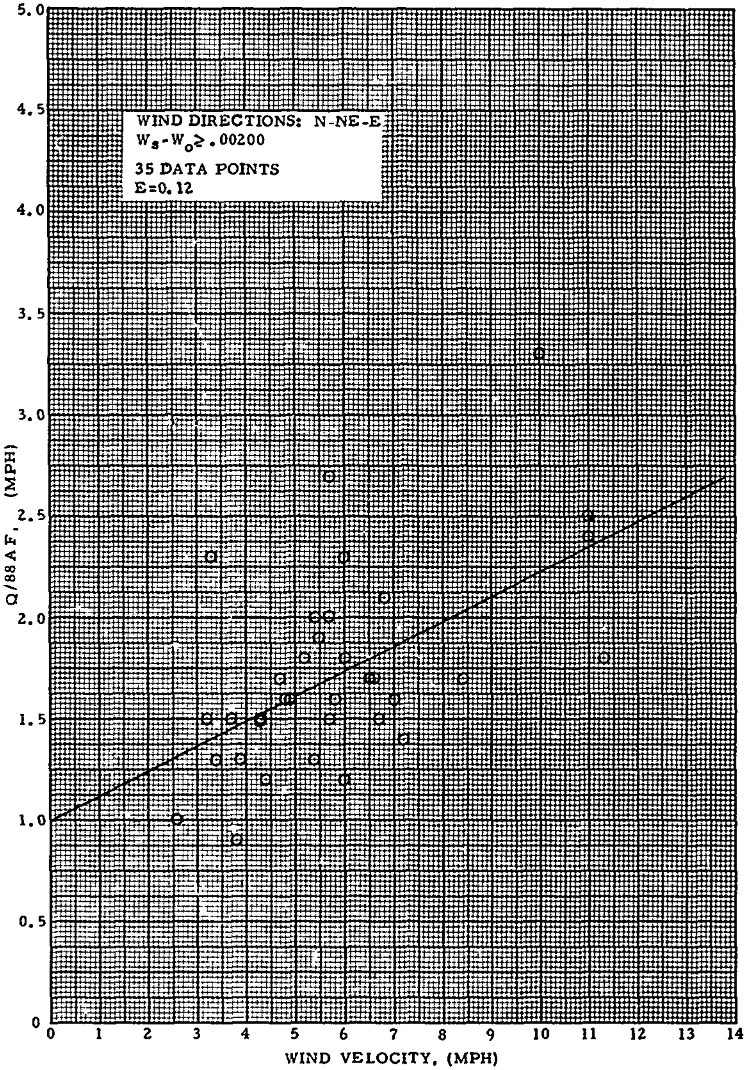


Figure 12 CORRELATION OF DATA FOR N-NE-E WIND SECTOR

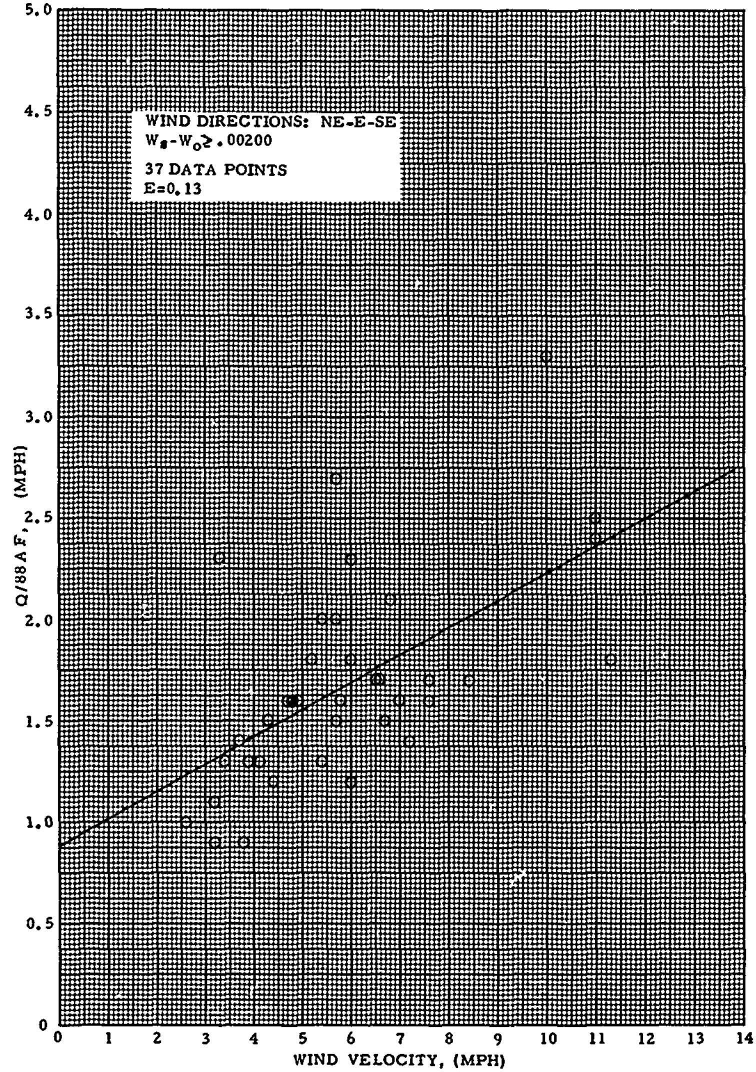


Figure 13 CORRELATION OF DATA FOR NE-E-SE WIND SECTOR

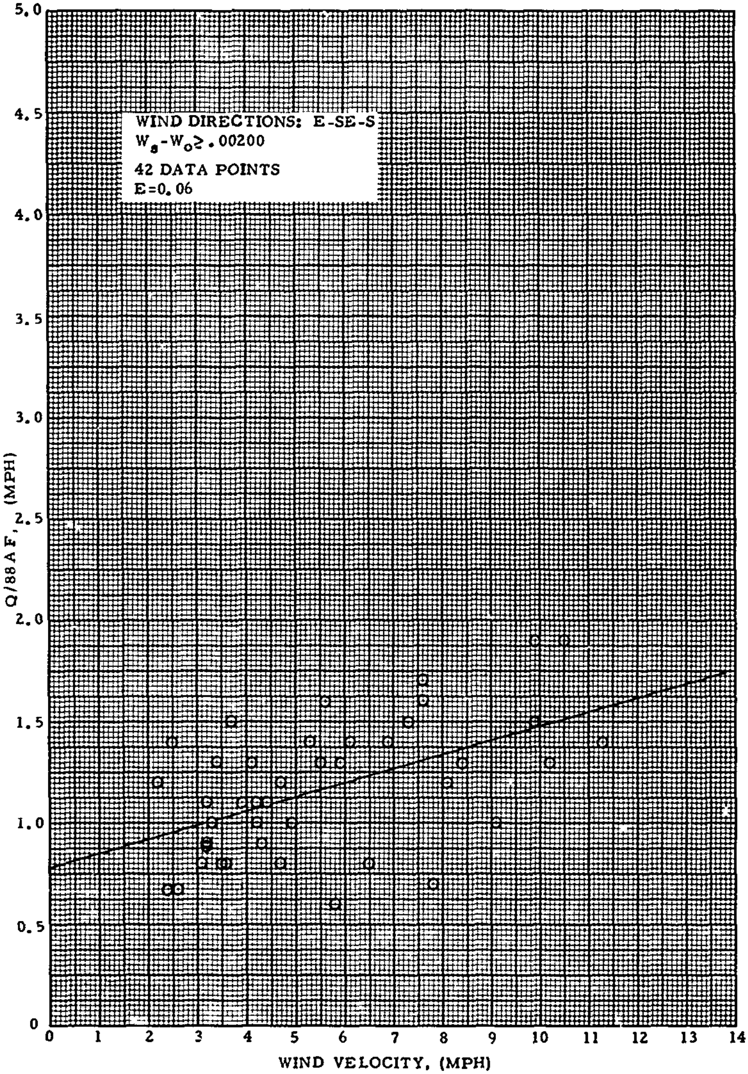


Figure 14 CORRELATION OF DATA FOR E-SE-S WIND SECTOR

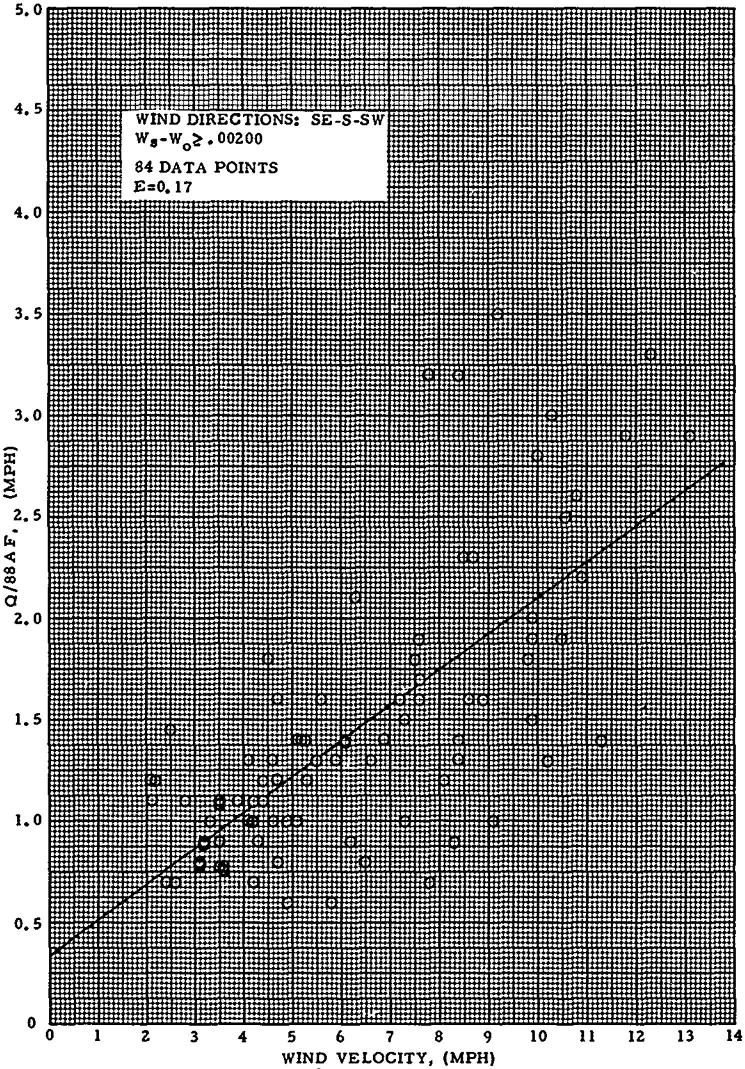


Figure 15 CORRELATION OF DATA FOR SE-E-SW WIND SECTOR

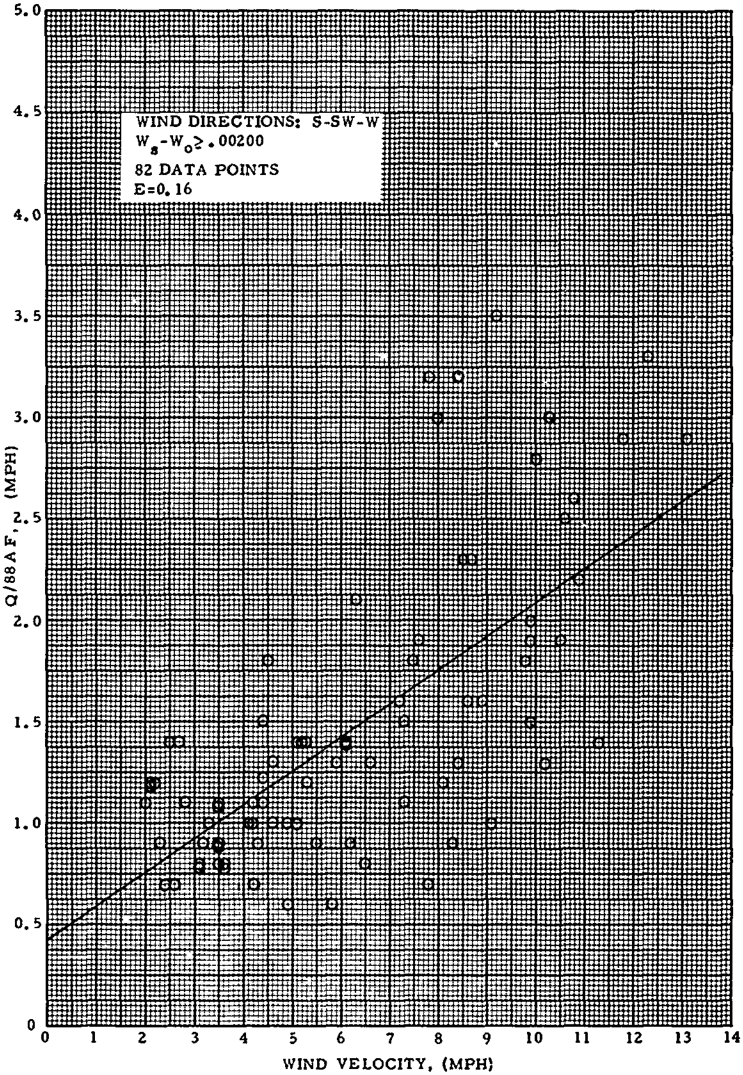


Figure 16 CORRELATION OF DATA FOR S-SW-W WIND SECTOR

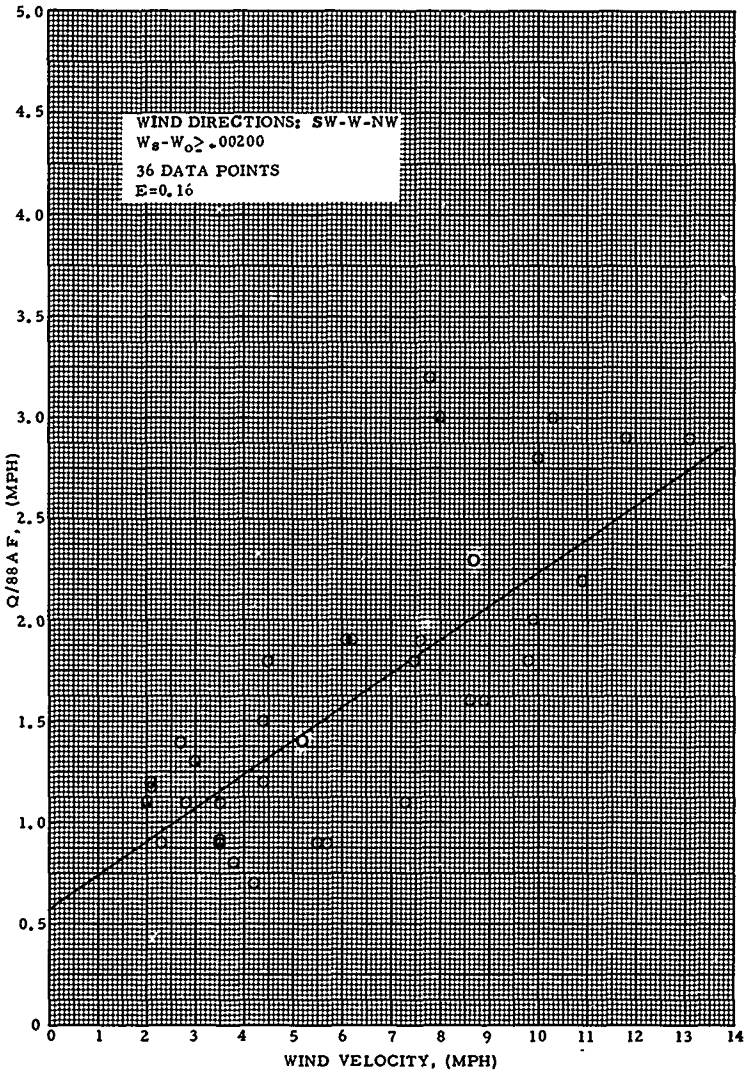


Figure 17 CORRELATION OF DATA FOR SW-W-NW WIND SECTOR

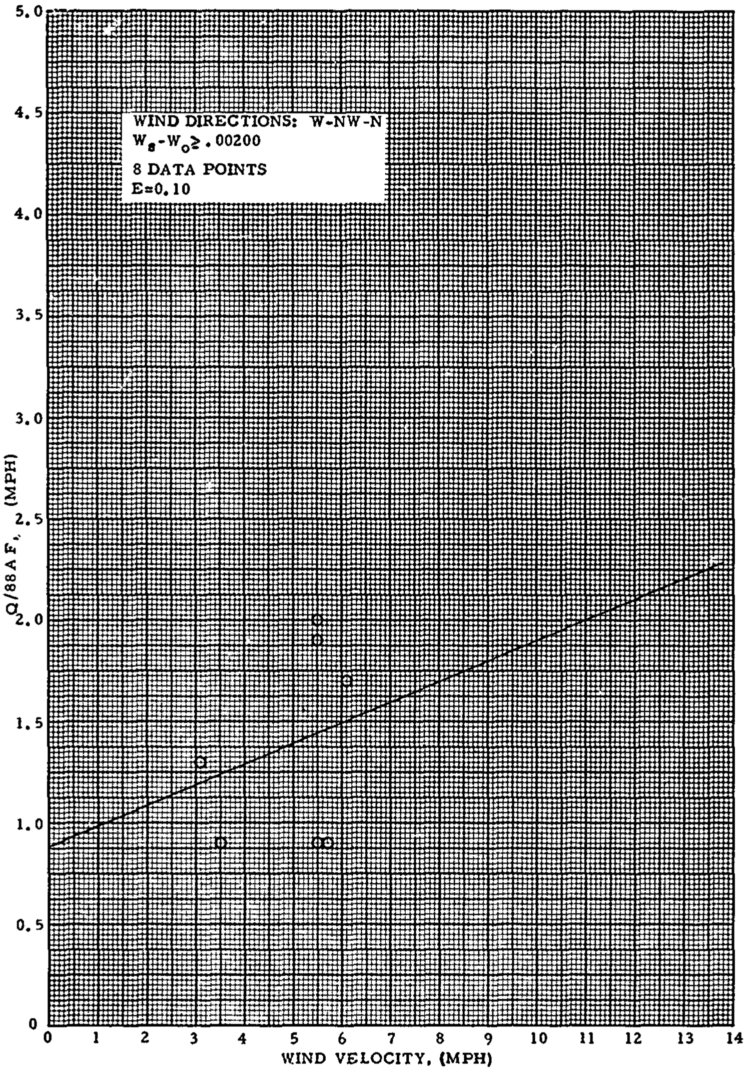


Figure 18 CORRELATION OF DATA FOR W-NW-N WIND SECTOR

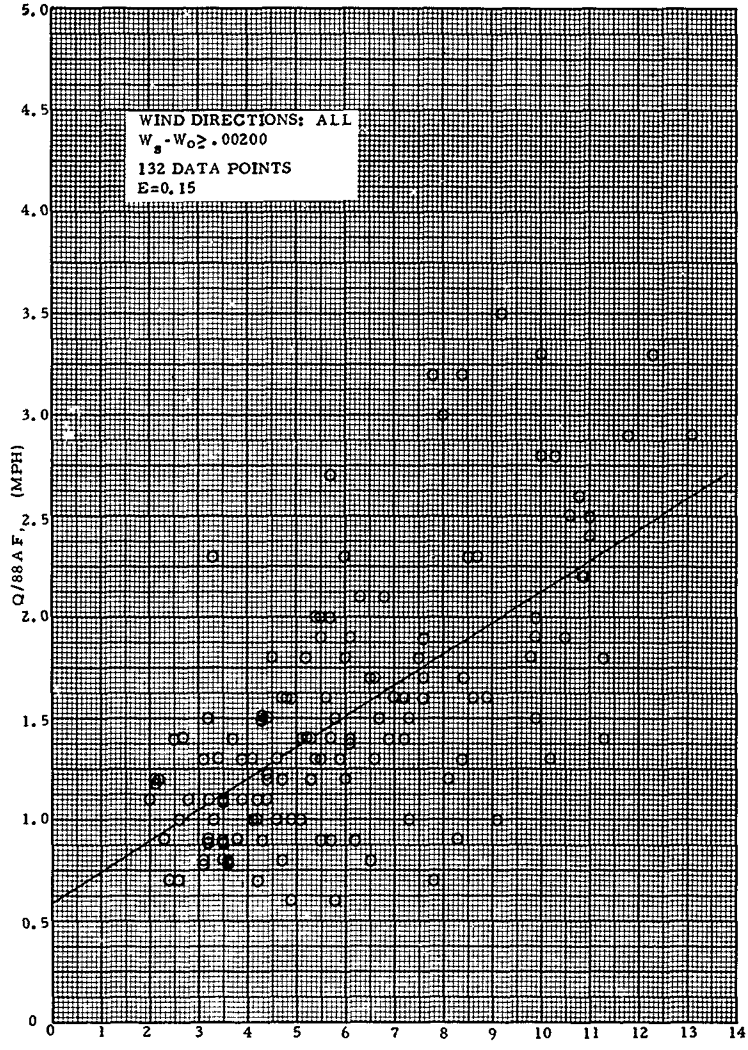


Figure 19 CORRELATION OF DATA FOR ALL WIND SECTORS

Table 2 DIRECTION DEPENDENCE OF E-FACTOR (for F = 1.0)

Wind Directions		Humidity Difference - $lb_w/lb_{d.a.}$ $[W_s - W_o]$		
		≥ .00200	≥ .00150	≥ .00100
ALL		0.15 (132)	0.16 (164)	0.24 (225)
NNW-N-NNE	45° Wind Sectors	0.21 (4)	0.24 (6)	0.33 (17)
NNE-NE-ENE	45° Wind Sectors	0.12 (32)	0.17 (49)	0.22 (73)
ENE-E-ESE	45° Wind Sectors	0.19 (12)	0.32 (17)	0.49 (23)
ESE-SE-SSE	45° Wind Sectors	0.13 (11)	0.15 (12)	0.15 (12)
SSE-S-SSW	45° Wind Sectors	0.16 (55)	0.15 (59)	0.16 (66)
SSW-SW-WSW	45° Wind Sectors	0.20 (50)	0.21 (55)	0.21 (69)
WSW-W-WNW	45° Wind Sectors	0.12 (11)	0.12 (15)	0.15 (24)
WNW-NW-NNW	45° Wind Sectors	0.10 (4	-0.03 (7)	0.13 (15)
NW-N-NE	90° Wind Sectors	0.09 (25)	0.15 (41)	0.21 (73)
N-NE-E	90° Wind Sectors	0.12 (35)	0.18 (54)	0.27 (89)
NE-E-SE	90° Wind Sectors	0.13 (37)	0.18 (55)	0.25 (79)
E-SE-S	90° Wind Sectors	0.06 (42)	0.07 (46)	0.20 (53)
SE-S-SW	90° Wind Sectors	0.17 (84)	0.18 (91)	0.18 (105)
S-SW-W	90° Wind Sectors	0.16 (82)	0.17 (91)	0.17 (109)
SW-W-NW	90° Wind Sectors	0.16 (36)	0.17 (44)	0.16 (63)
W-NW-N	90° Wind Sectors	0.10 (8)	0.16 (14)	0.27 (30)

NOTES: Number of hourly data points for each correlation are given in parenthesis.

Results are for all tests, day and night hours, and for all wind velocities.

Table 3 DIRECTION DEPENDENCE OF E-FACTOR (for $F = F_{actual}$)

Wind Directions		Humidity Difference - $lb_w/lb_{d.a.}$ (W_s-W_o)		
		$\geq .00200$	$\geq .00150$	$\geq .00100$
ALL		0.15 (132)	0.21 (164)	0.26 (225)
NNW-N-NNE	45° Wind Sectors	0.18 (4)	0.34 (6)	0.40 (17)
NNE-NE-ENE		0.11 (32)	0.29 (49)	0.26 (73)
ENE-E-ESE		0.23 (12)	0.44 (17)	0.60 (23)
ESE-SE-SSE		0.09 (11)	0.11 (12)	0.11 (12)
SSE-S-SSW		0.18 (55)	0.17 (59)	0.18 (66)
SSW-SW-WSW		0.25 (50)	0.26 (55)	0.25 (69)
WSW-W-WNW		0.12 (11)	0.12 (15)	0.19 (24)
NWN-NW-NNW		-0.07 (4)	-0.13 (7)	0.13 (15)
NW-N-NE	90° Wind Sectors	0.09 (25)	0.25 (41)	0.24 (73)
N-NE-E		0.12 (35)	0.30 (54)	0.33 (89)
NE-E-SE		0.11 (37)	0.29 (55)	0.31 (79)
E-SE-S		-0.01 (42)	0.00 (46)	0.16 (53)
SE-S-SW		0.17 (84)	0.17 (91)	0.18 (105)
S-SW-W		0.16 (82)	0.17 (91)	0.17 (109)
SW-W-NNW		0.15 (36)	0.16 (44)	0.16 (63)
W-NW-N		0.11 (8)	0.16 (14)	0.28 (30)

NOTES: Number of hourly data points for each correlation are given in parenthesis.

Results are for all tests, day and night hours, and for all wind velocities.

and compared to the Weather Bureau observations. The temperature and wind conditions, which existed during the testing period are presented in Figs. 20 to 26.

Good correlation between Weather Bureau and shelter observed wind direction were obtained even when the local wind direction was such that the shelter was shielded by adjacent buildings. Wind speed observations compared favorably except when the wind was out of the north or northeast where the shelter was shielded. For these directions, the Weather Bureau readings were approximately 5 mph greater than those observed at the shelter.

During the twelve day testing period, the average wind speed recorded at the shelter was 7.4 mph; the average wind speed as recorded at the Weather Bureau for the same period was 9.7 mph. The difference in agreement is probably due to the shielding effects which existed during certain wind periods and also due to the manner in which the two readings were recorded. The Weather Bureau's determination is an instantaneous reading taken once every hour on the hour for a one minute interval. The shelter observation is an integrated or average determination which was recorded over the entire hour by the Wind Speed Transmitter. The shelter observation would give a truer indication of the average wind speed. Difference in readings may also be due to the Weather Bureau observations being made at a point 20 feet above-grade while the shelter observations were made 95 feet above-grade.

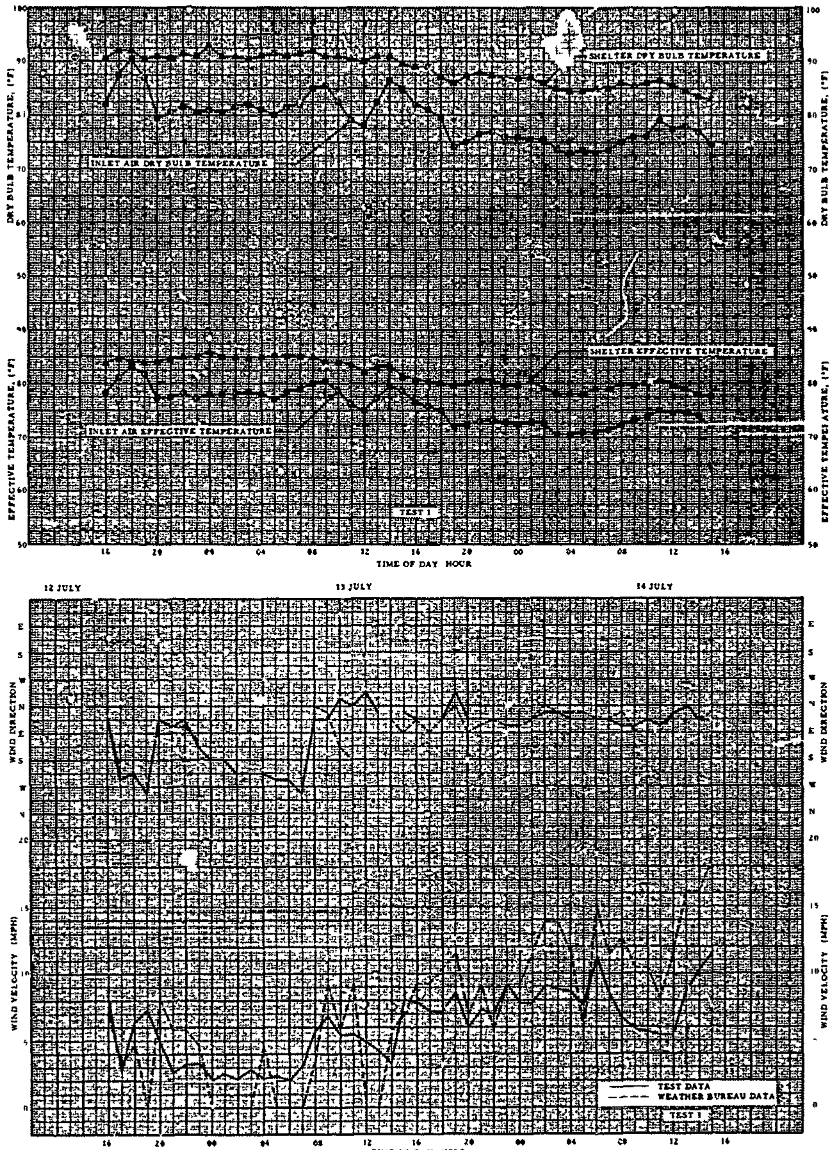


Figure 20 TEST 1 TEMPERATURES AND WIND CONDITIONS

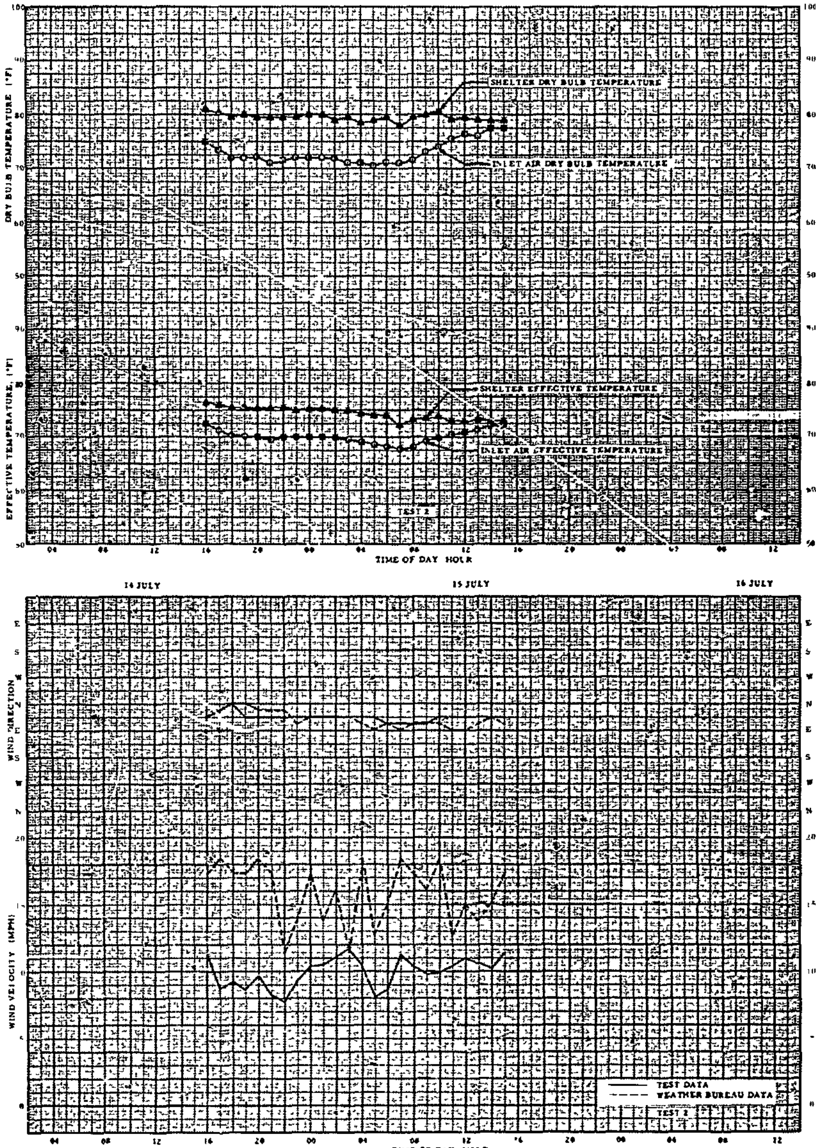


Figure 21 TEST 2 TEMPERATURES AND WIND CONDITIONS

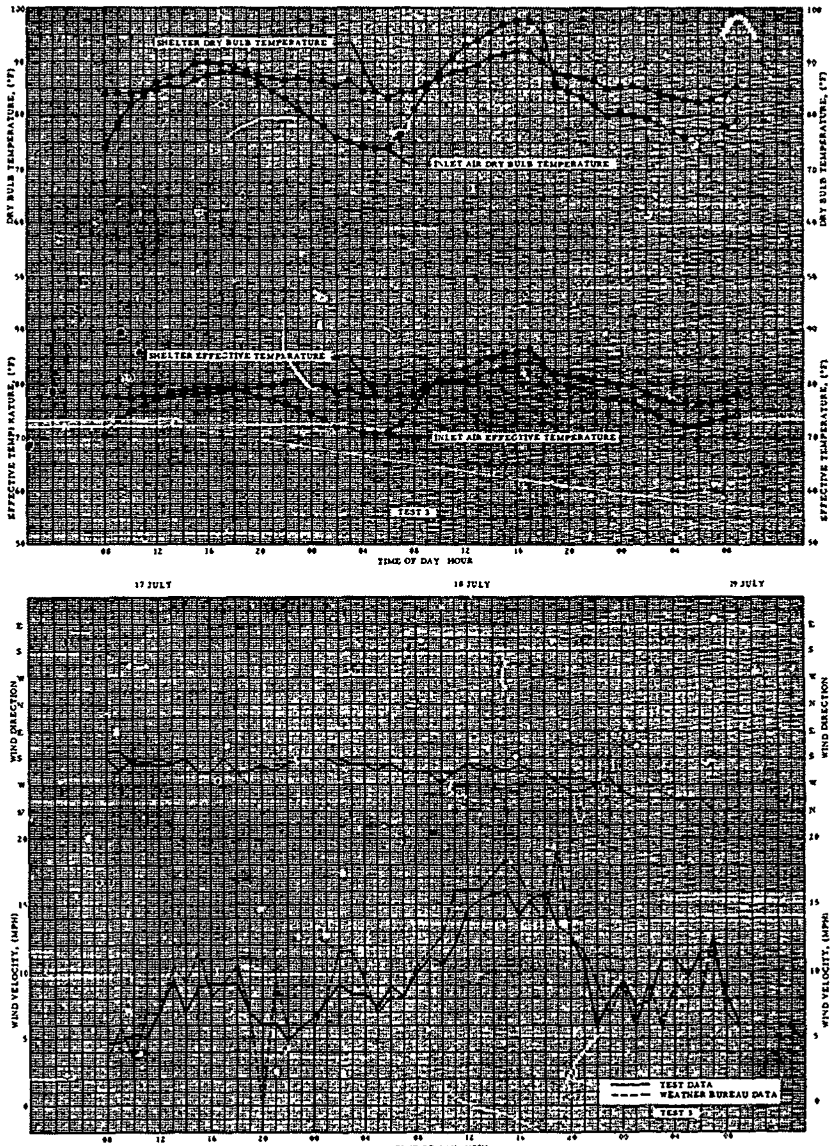


Figure 22 TEST 3 TEMPERATURES AND WIND CONDITIONS

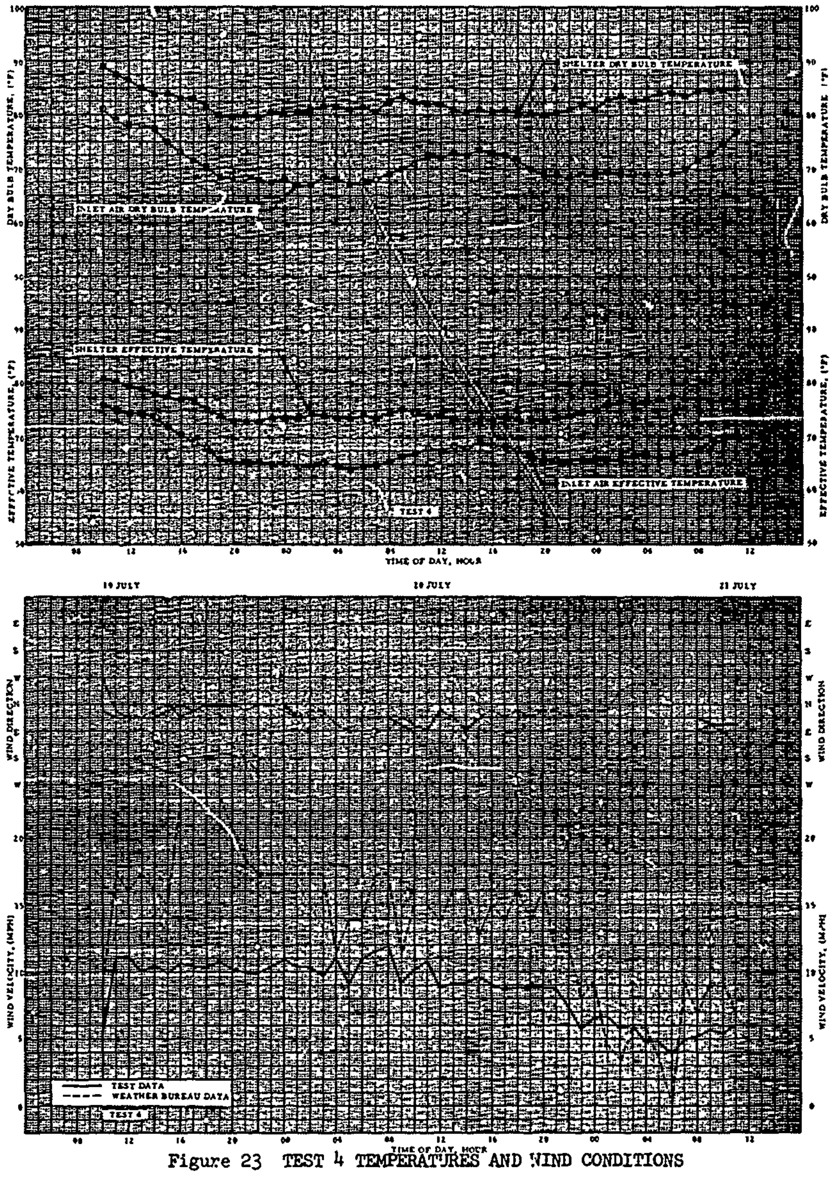


Figure 23 TEST 4 TEMPERATURES AND WIND CONDITIONS

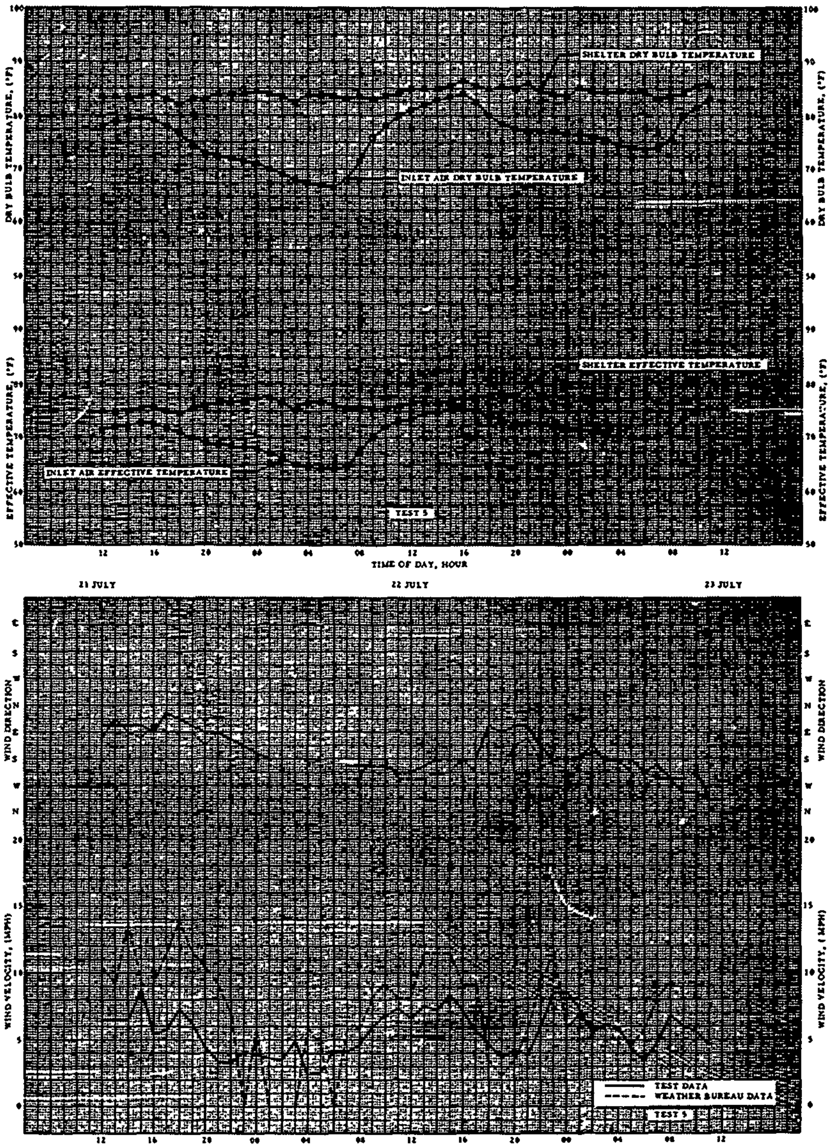


Figure 24 TEST 5 TEMPERATURES AND WIND CONDITIONS

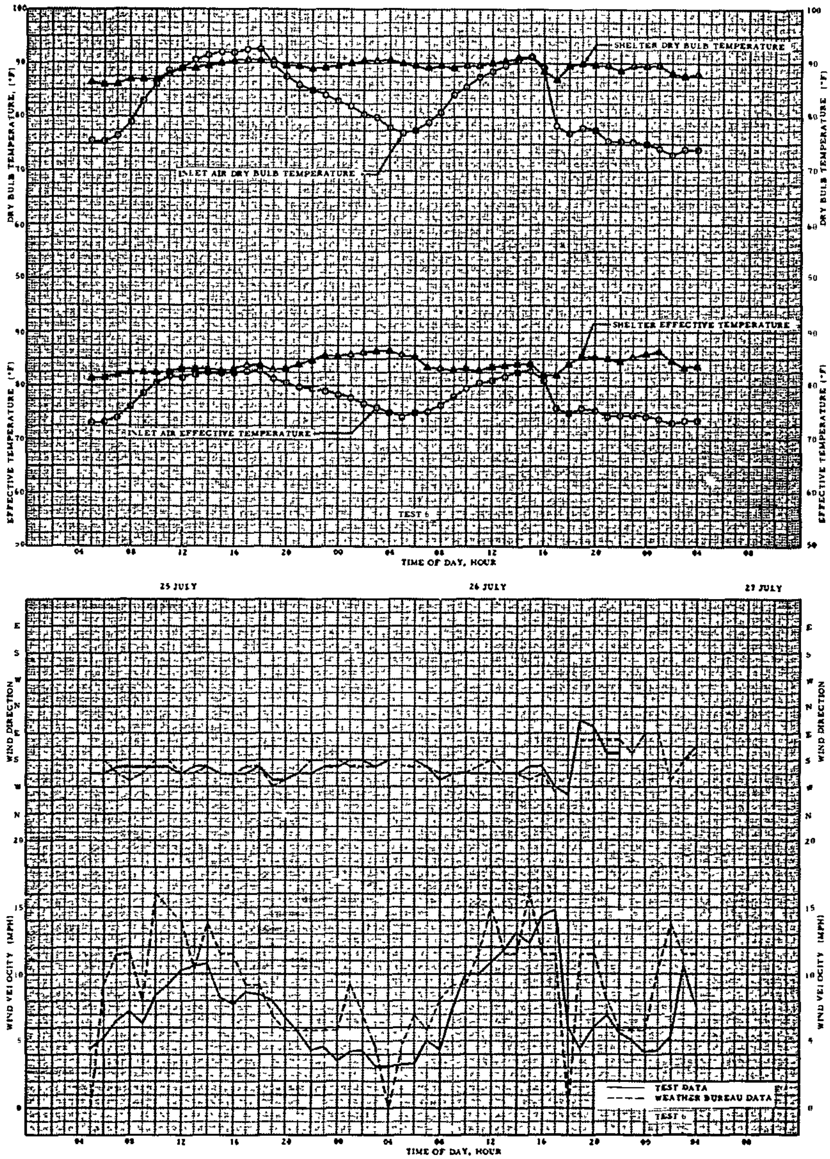


Figure 25 TEST 6 TEMPERATURES AND WIND CONDITIONS

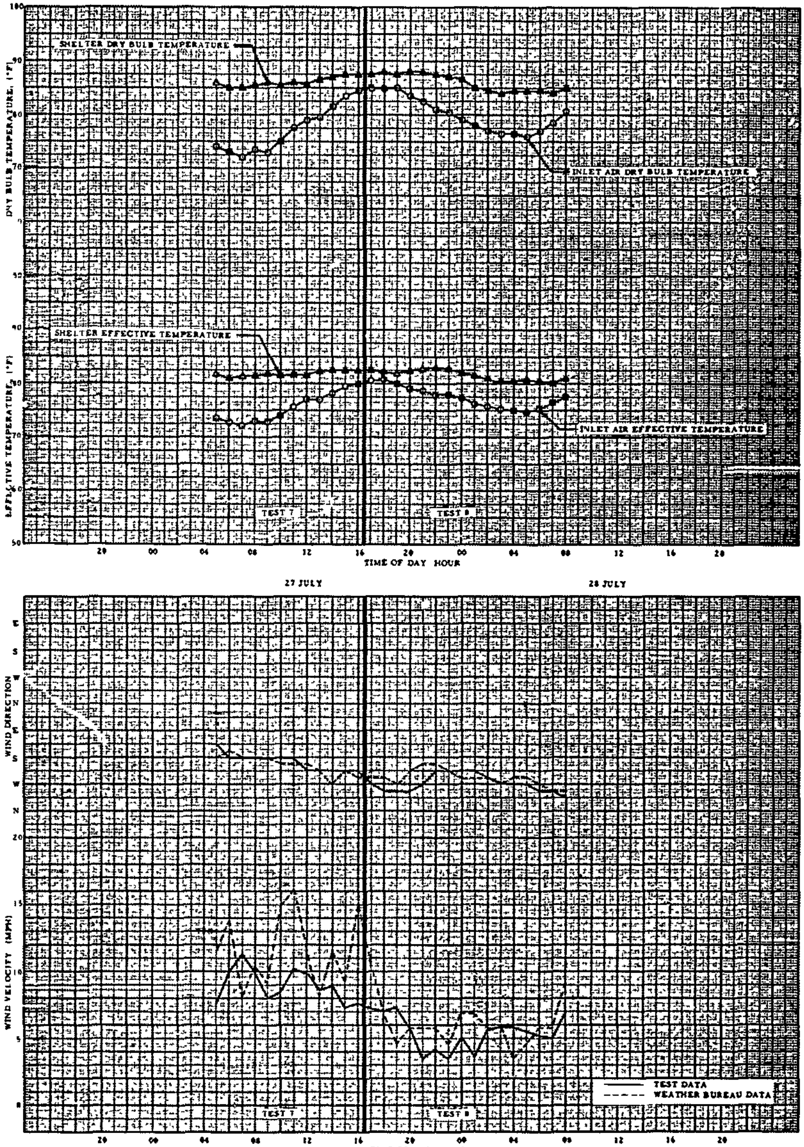


Figure 26 TESTS 7 AND 8 TEMPERATURES AND WIND CONDITIONS

5.4 Error Analysis

The following analysis is made in order to evaluate the accuracy of the indicated ventilation rate as measured by equation 1.

Given a function of n number of variables, the relative error in P, $\frac{d(P)}{P}$, is defined as

$$\frac{d(P)}{P} = \frac{1}{P}\left[\left(\frac{\partial P}{\partial X_1}\right) d(X_1) + \left(\frac{\partial P}{\partial X_2}\right) d(X_2) + \ldots\ldots + \left(\frac{\partial P}{\partial X_n}\right) d(X_n)\right] \quad (3)$$

where:

$d(P)$ = absolute error in the property, P

$d(X_1)$ = absolute error in the variable, X_1, due to experimental measurement

$\frac{\partial P}{\partial X_1}$ = absolute error contribution to the property, P, due to the variable, X_1, with all other variables held fixed.

Using this method, an estimation of the relative error in the measured air flow is made in this section.

Applying the above discussion to equation 1, the relative error in the measured ventilation rate is:

$$\frac{d(Q)}{Q} = \left[\frac{d(M_w)}{M_w}\right] + \left[\frac{d(v_o)}{v_o}\right] - \left[\frac{d(W_s - W_o)}{(W_s - W_o)}\right] \quad (4)$$

The water input to the shelter was measured to the nearest half-pound, thus $d(M_w) \leq \pm 0.25$. The specific volume, v_o, can be read from the psychrometric chart within 0.1 cubic feet per pound of dry air, so $d(v_o) \leq \pm 0.05$. Dry-bulb and wet-bulb temperatures were read to the nearest half-degree giving a corresponding inaccuracy to the humidity ratio of $d(W_s - W_o) \leq \pm 0.0005$ (from the psychrometric chart).

Therefore,

$$\frac{d(Q)}{Q} = \left[\frac{\pm 0.25}{M_w}\right] + \left[\frac{\pm 0.05}{v_o}\right] - \left[\frac{\pm 0.0005}{W_s - W_o}\right] \qquad (5)$$

Throughout the test these relationships held.

$$M_w \geq 12.0 \text{ lbs/hr}$$

$$v_o \geq 13.0 \text{ ft}^3\text{/lb}$$

Therefore, considering the relative magnitudes of the terms in equation 5, the relative error can be approximated as

$$\frac{d(Q)}{Q} \leq \frac{0.0005}{W_s - W_o}$$

and for periods when

$$\left[W_s - W_o\right] \geq 0.0020,$$

we have

$$\frac{d(Q)}{Q} < 0.25$$

or the maximum possible error due to measurement in the measured air flow rate is less than 25 percent. Table 4 summarizes the measurement error for various humidity ratio differences and indicates the corresponding number of hourly data points that are available for analysis.

Table 4

Measurement Error

$\left[W_s - W_o\right]$	Max. Possible Error	No. of Data Points
$\geq$ 0.00100	< 50.0%	225
$\geq$ 0.00150	< 33.3%	164
$\geq$ 0.00200	< 25.0%	132

NOTE: As $\left[W_s - W_o\right]$ decreases, you are in effect including points which have higher ventilation rates.

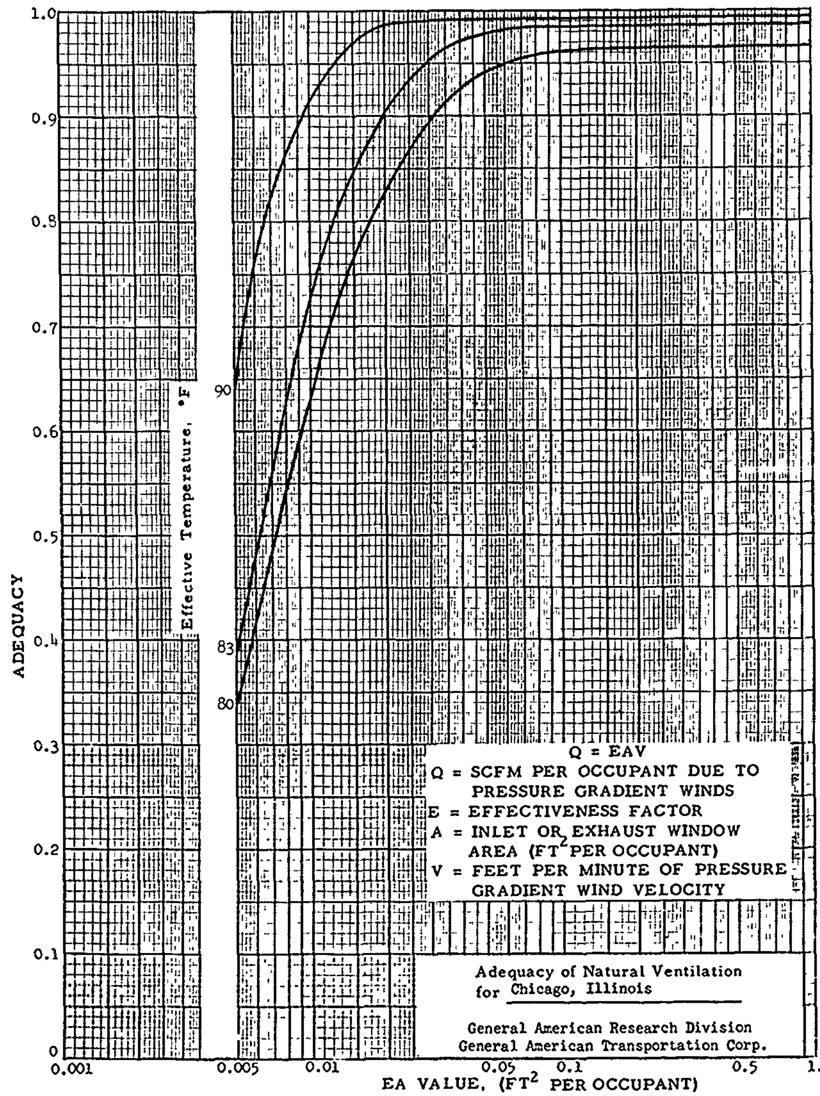
5.5 Adequacy of Natural Ventilation

With the aid of results from a companion study (Ref. 9) conducted at GARD it is possible to establish adequacy limits for a shelter located in Chicago and ventilated by natural ventilation only. The results of the study are presented in the form of adequacy curves which were generated based upon ten years of hourly Weather Bureau recordings of wind condition and wet and dry-bulb temperatures. Once the EA value for a particular shelter is known, the adequacy curve can be entered and for a desired maximum shelter effective temperature the adequacy of natural ventilation determined.

For the Chicago shelter, an overall window effectiveness factor of 0.15 was calculated. Assuming that the maximum open window area is obtained when the bottom sash of each window is raised to its extreme, the total area available for inlet air, assuming equal inlets and outlets, is 119 square feet. Using all available floor area that has a radiation protection factor of greater than 40 (see Section 2.4), the maximum occupancy level at 10 square feet per person is 275 occupants. The EA value of the shelter can then be established as:

$$EA = \frac{0.15 \times 119}{275} = 0.065 \text{ square feet per occupant}$$

Entering the abscissa of Fig. 27 at a value of EA = 0.065 square feet per occupant and for a limiting shelter ET of 83°F, the adequacy of natural ventilation for this shelter is 0.982. This means that 98.2% of the time, or for all but seven of the days during the year natural ventilation will adequately ventilate the shelter such that the ET will not rise above 83°F with 275 occupants within the shelter.



Figt e 27 NATURAL VENTILATION ADEQUACY CURVE FOR CHICAGO, ILLINOIS

If the occupancy density is lowered to 8 square feet per occupant, 344 occupants will be able to be housed within the shelter and the resultant value of EA is 0.052 square feet per occupant. The adequacy for the same limiting shelter ET of 83°F is then reduced to 98.0%. This change is negligible.

If the lowest E recorded in Table 2 for the 90° wind sector analysis was used instead of the overall E, the resulting change in adequacy is less than one percent. The overall E can therefore be used as a design value for a corridor-type shelter located in Chicago.

5.6 Comparison of Ventilation Rates

A simplified equation for estimating natural ventilation due to wind forces for aboveground structures has been proposed by Dr. Richard Condit of Stanford Research Institute (Ref. 10). His work is based upon building codes for various sections of the country, and upon design values of wind speeds which are set forth in the 1963 ASHRAE Guide and Data Book. The following equation resulted:

$$\text{cfm/man} = (\text{floor area in sq. ft./man}) \times (\text{wind speed in mph}) \qquad (6)$$

For the wind speed Dr. Condit suggests that the adjusted ASHRAE hot weather design values (Ref. 11) of H (high) = 5.5 mph, M (medium) = 3.5 mph, and L (low) = 2.0 mph be used. For Chicago the design value wind speed is M or 3.5 mph. Using 10 square feet of floor area per man, Dr. Condit's equation predicts 35 cfm/man which gives a ventilation adequacy of 97.7%.

The expected ventilation rate for this shelter can be calculated using the equation Q = EAV and the experimental values for effectiveness factor (0.15) and average wind speed (7.4 mph) obtained from these tests. If we

assume that one-half of the openable window area of the shelter acts as an air inlet, then F, the unequal inlet-outlet area factor, equals 1.0, and A = 119 square feet. It follows that the ventilation rate per shelteree is

$$Q = 88(1.0)(0.15)(119)(7.4)/275 = 42.3 \text{ cfm/man}$$

Therefore, Condit's formula predicts a ventilation rate about 20% less than the rate derived from the average experimental results. With this particular shelter, Condit's method appears to be useful for predicting general expected ventilation rates.

SECTION 6

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are made based on the test data:

1. An overall window effectiveness factor of 0.15 was obtained from the correlation between wind speed and ventilation rate. This window effectiveness factor is independent of wind direction.
2. The shelter will be adequately ventilated 98.2% of the days during the year. This estimate is based upon a compilation of ten years of Weather Bureau data and a calculated EA value of 0.065 sq ft/occ for the shelter.
3. Half the windows functioned as inlets and half as outlets based upon ASHRAE E-factor analysis.
4. In general, the highest winds occurred during the warmest period of the day (1200-1600 hours), and some air movement was observed at all times with the hourly averaged wind velocity never being lower than 2.0 mph.
5. Future natural ventilation work should center around three objectives:
    a. Run modeling studies using a low speed wind tunnel to test scale models of actual buildings already tested and then formulate a law to predict natural ventilation.
    b. Determine adequacy curves for natural ventilation of building located in other cities than Chicago using existing weather data.

REFERENCES

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2. ASHRAE Guide and Data Book, 1965 Edition, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., New York, New York.

3. "Measurement of Natural Draft", The College of Engineering, The Pennsylvania State University, Contract No. OCD-OD-62-64, University Park, Pennsylvania, December 1963, p. 35.

4. ASHRAE, op. cit., eqn. 5, p. 465.

5. Madson, C. A., et. al., "Natural Ventilation Test of an Aboveground Fallout Shelter in Bozeman, Montana", GATC Interim Report, MRD 1195-56-2, Contract No. OCD-OS-62-134, DDC No. 453070, Niles, Illinois, November 1964.

6. Madson, C. A., et. al., "Natural Ventilation Test of an Aboveground Fallout Shelter in Baton Rouge, Louisiana", GATC Interim Report, MRD 1268-20, Contract No. B-64220(4949A-16)-US, DDC No. 456893, Niles, Illinois, January 1965.

7. Meier, H. A., et. al., "Natural Ventilation Test of an Aboveground Fallout Shelter in Evanston, Illinois", GATC Interim Report, GARD 1268-51, Contract No. B-64220(4949A-16)-US, Niles, Illinois, January 1966.

8. Henninger, R. H., et. al., "Natural Ventilation Test of a Basement Fallout Shelter in East Chicago, Indiana", GATC Interim Report, GARD 1266-61, Contract No. B-64220(4949A-16)-US, Niles, Illinois, January 1966.

9. Baschiere, R. J., et. al., "Summary Report On The Reliability of Natural Ventilation and Evaporative Cooling In Shelters", GATC Report 1266-1, Contract No. B-60421(4949A-4)-US, Niles, Illinois, November 1966.

10. Personal Communication with Dr. R. I. Condit of Stanford Research Institute, Menlo Park, California.

11. ASHRAE, op. cit., Table I, p. 470.

12. ASHRAE, op. cit., Fig. 7, p. 107.

APPENDIX A

PROTECTION FACTOR ANALYSIS

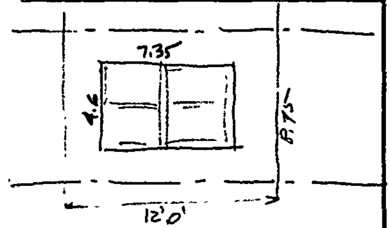
FOR STUDENT RESIDENCE HALL

GATX GENERAL AMERICAN RESEARCH DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION
7449 NORTH NATCHEZ AVENUE NILES ILLINOIS 60648

CALCULATION SHEET

Job Order No. 1268-80 | Contract No.

Shelter Analysis of 818 S. Wolcott



Wall Mass: 8" Brick = 74 psf
3/4" Plaster = 6
80 = X_e

Corridor Partition 4" Tile = 18
1½" Plas = 12
30

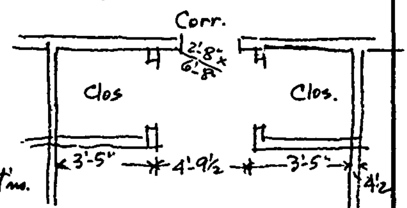
Closet Partition: 3" Tile = 13
1½" Plas = 12
25

$A_p = \frac{4.6 \times 7.35}{8.75 \times 12.0} = .322$ (Area)

$P_a = \frac{7.35}{12} = .612$

Floor Mass:
4 Concrete = 50 = X_f

Roof Mass
4" Concrete = 50
5 Ply Roof'g = 7
57 = X_r



Average of Corridor plus Closet Part'ns.

Corr. Part'n Area = 8.4 x 12.0 = 100 sf
Less Door 2.67 x 6.67 = 17.8
82.2 sf x 30 psf = 2460#
Closet Part'ns. 6.83' x 8.4' x 25 psf = 1440#
3900# ÷ 100 sf
= 39 psf = X_i

End Walls: 8" Brick = 74 psf
3" Tile = 13
3/4" Plaster = 6
93 psf

Spandrel Beam 4" Brick = 37
13" Conc = 163
200 psf

Prepared By W.B. Cobb — W. B. Cobb, Registered Fallout Shelter Analyst | Date July 12, 1966
Checked By | Date

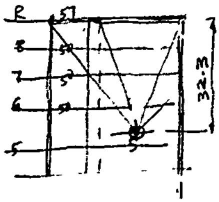
Form 127

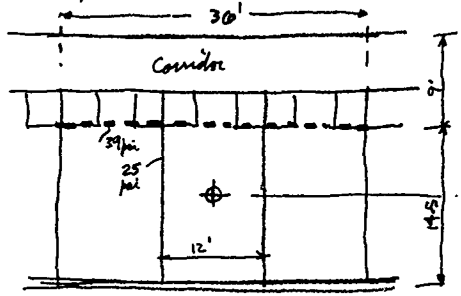
Job Order No. 1268-80

Contract No.

Protection Factor at Center of Dormitory Rm.

Overhead Contribution





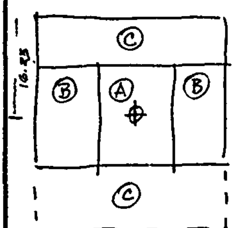
Assumptions:

1.) Assume no overhead contribution from area beyond adjacent dormitory rooms or from other side of corridor.

2.) Assume mass of corridor & closet walls ($X_i = 39$psf) concentrated on on dashed line.

$X_o = 207$ $\quad B_i'(X_i = 39) = .275$

$B_i'(X_i = 25) = .425$



ω	W	L	Z	e	n	ω	$C_o(X_o = 207)$
ω_A	12	14.5	32.3	.825	4.45	.025	.00015
ω_B	14.5	36	32.3	.403	1.8	.07	.00042
ω_C	32.5	36.	32.3	.903	1.8	.145	.00075

Contrib. Ⓐ $= C_o(\omega_A)$ $= .000150$

Contrib. Ⓑ $= [C_o(\omega_B) - C_o(\omega_A)]B_i'(X_i = 25) = (.00042 - .00015).425 = .000115$

Contrib. Ⓒ $= \frac{1}{2}[C_o(\omega_C) - C_o(\omega_B)]B_i'(X_i = 39) = \frac{(.00075 - .00042).275}{2} = .000045$

Total C_o = .00031

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Form 127

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GENERAL AMERICAN TRANSPORTATION CORPORATION
7449 NORTH NATCHEZ AVENUE NILES ILLINOIS 60648

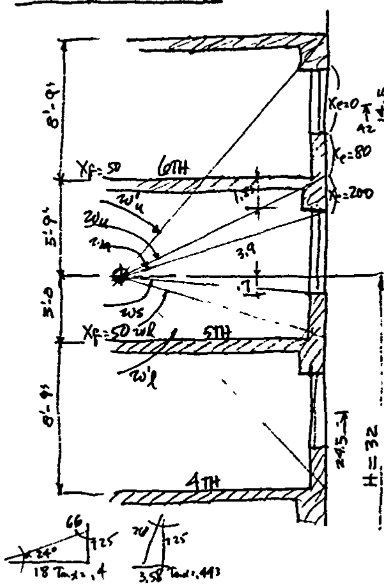
CALCULATION SHEET

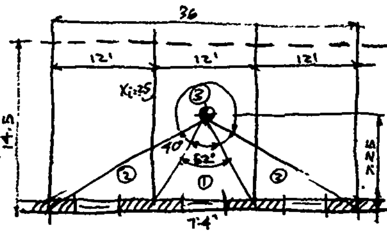
Job Order No. 1268-80

Contract No.

PF at ℄ of Dormitory Room (Cont'd)

Ground Contribution





Assumptions

1. No contribution beyond adjacent room or across corridor
2. No mutual shielding
3. Height to 1st floor roof which is assumed as infinite contam. plane
4. Spandrel beam heavier than wall. (See p.1)

$A_{3}① = \frac{52}{360} = .144$ $P_a = \frac{7.35}{12} = .612$

$A_{3}② = \frac{80}{360} = .222$ $A_p = \frac{4.6 \times 7.35}{8.75 \times 12} = .222$

$A_{3}③ = \frac{228}{360} = .634$

w.	W	L	Z	e	n	ω	Gd H=32	Ga	Gs
w'u	14.5	36	14.5	.403	.805	.123	—	.094	.45
wu	"	"	5.75	"	.319	.54	—	.082	.38
wa	"	"	3.9	"	.216	.66	—	.074	.31
ws	"	"	.7	"	.039	.934	.06	—	.078
wl	"	"	3	"	.167	.73	.375	—	.27
w'l	"	"	11.75	"	.653	.295	.72	—	.44

$E(e = .403) = 1.3$

$S_w(X_e = 80) = .69$, $(1-S_w) = .31$

$S_w(X_e = 200) = .85$ $(1-S_w) = .15$

$B_e(X_e = 80, H = 32) = .08$

$B_e(X_e = 200, H = 32) = .0056$

$B_i(X_i = 25) = .54$ (point)

$B'_o(X_o = 50) = .066$ (f above)

$B_e(X_e = 50) = .08$ (f below)

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Form 127

CALCULATION SHEET

Job Order No.	Contract No.
1268-80	

PF at ℄ of Dorm. Rm (Cont'd)
Ground Contribution – Cont'd

① Story of Detector (5th Floor) $B_e(\text{glass}) = B_e(X_e=0, H_d=32') = .59$

Strip of Wall above Windows: (Fictitious Bldg w/o Part'ns)

$$C_g = \left\{\left[G_a(\omega_u) - G_a(\omega_\ell)\right]\left[1-S_w\right]_{(Xe=200)} + \left[G_s(\omega_u) - G_s(\omega_\ell)\right] S_w . E\right\} B_e\binom{X_e=200}{H_d=32} =$$

$$= \left[(.082-.074)(.15) + (.38-.31)(.85)(1.3)\right].0056$$

$$= (.0012 + \underset{.0784}{.0772}).0056 \qquad = .000438$$

Solid Wall except above windows:

$$C_g = \left\{\left[G_d(\omega_\ell, H_d) - P_a \cdot G_d(\omega_s, H_d) + (1-P_a)(G_a(\omega_\ell))\right]\left[1-S_w(X_e=80)\right] + \right.$$

$$\left.\left[(1-P_a)\,G_s(\omega_s) + G_s(\omega_\ell) - P_a\,G_s(\omega_s)\right] S_w(X_e=80)\ E(e)\right\} B_e\binom{X_e=80}{H_d=32}$$

$$= \left\{\left[.375 - (.612 \times .06) + (.388 \times .074)\right](.31) + \left[(.388 \times .31) + .27 - (.612 \times .078)\right](.69)(1.3)\right\}.08$$

$$\left[(.375 - .0367 + .0287)(.31) + (.12 + .27 - .0477)(.91)\right].08$$

$$\left[(.367)(.31) + (.3423)(.91)\right].08 = (.1137 + .3113)(.08) = (.425)(.08) = \quad .034000$$

Glass:

$$C_g = P_a\left\{\left[G_d(\omega_s, H_d) + G_a(\omega_\ell)\right]\left[1 - S_w(X_e=0)\right]\right\} B_e\binom{X_e=0}{H_d=32}$$

$$= .612\left[(.06 + .074)(1)\right].59 = (.612)(.134)(.59) = . \qquad \underline{.0484}$$

Total for Floor of Detector (5th) = .0828

For floors above & below, average out weight of wall:

$$\frac{(12 \times 1.85 \times 200) + (12 \times 6.9 \times 80)}{12 \times 8.75} = \frac{11060}{105} = 105 \text{ psf}$$

$S_w(X_e=105) = .75 \quad (1-S_w) = .25 \quad B_e(X_e=105\ H_d=42) = .04$ (6th Floor) $\quad B_e(X_e=105\ H_d=24.5) = .05$ (4th Floor)

Prepared By WBCobb — W. B. Cobb, Registered Fallout Shelter Analyst — Date 7-13-66

Checked By — Date

Form 127

CALCULATION SHEET

Job Order No 1268-80 | Contract No.

P_f at ℄ of Dorm Rm (Cont'd)

Ground Contact - Cont'd

(B) 6th Floor Contribution $B_e(\text{Glass}) = B_e(X_e = 0, H_d = 42) = .54$

Solid Wall:

$$G_g = \left\{\left[G_a(\omega_u') - G_a(\omega_u)\right]\left[1 - S_{w}\right]_{X_e=105} + \left[G_s(\omega_u') - G_s(\omega_u)\right] S_w(E)_{(X_e=105)}\right\} B_{e\,(X_e=105,\,H_d=42)}\, B_o'\left(\tfrac{X_o}{50}\right)(1-A_p)$$

$$= \left[(.094 - .082)(.25) + (.45 - .38)(.75)(1.3)\right](.04)(.066)(1-.322)$$

$$= \left[(.012)(.25) + (.07)(.75)(1.3)\right](.04)(.066)(.678)$$

$$= (.003 + .068)(.00179) = (.071)(.00179) = \quad .000127$$

Glass:

$$G_g = \left\{\left[G_a(\omega_u') - G_a(\omega_u)\right]\left[1 - \overset{0}{S_w}\right]_{(X_e=0)}\right\} B_{e\,(X_e=0,\,H_d=42)} \cdot B_o' \cdot A_p$$

$$= \left[(\underbrace{.094 - .082}_{.012})(1)\right](.54)(.066)(.322) = \quad .000138$$

Total 6th Fl .000365

(C) 4th Floor Contribution $B_e(\text{glass}) = B_e(X_e = 0, H_d = 24.5) = .64$

Solid Wall

$$G_g = \left\{\left[G_d(\omega_l')_{H} - G_d(\omega_l)_{H}\right]\left[1 - S_w\right]_{(X_e=105)} + \left[G_s(\omega_l') - G_s(\omega_l)\right] S_w \cdot E_{(X_e=105)}\right\} B_{e\,(X_e=105,\,H_d=24.5)}\, B_f(X_f=50)(1-A_p)$$

$$= \left[(.72 - .375)(.25) + (.44 - .27)(.75)(1.3)\right](.05)(.08)(1-.322)$$

$$= \left[(.345)(.25) + (.17)(.75)(1.3)\right](.05)(.08)(.678)$$

$$= (.086 + .167)(.00271) = (.253)(.00271) = \quad .000685$$

Glass.

$$G_g = \left\{\left[G_d(\omega_l') - G_d(\omega_l)\right]\left[1 - \overset{(0)}{S_w}\right]_{(X_e=0)}\right\} B_{e\,(X_e=0,\,H_d=24.5)} \cdot B_{f\,(X_f=50)} \cdot A_p$$

$$= \left[(\underbrace{.72 - .375}_{.345})(.1)\right](.64)(.08)(.322) = \quad .005675$$

Total 4th Fl. .006360

Prepared By W B Cobb — W. B. Cobb, Registered Fallout Shelter Analyst | Date 7-13-66

Checked By | Date

Form 127

GATX GENERAL AMERICAN RESEARCH DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION
7449 NORTH NATCHEZ AVENUE NILES ILLINOIS 60648

CALCULATION SHEET

Job Order No. 1268-80

Contract No.

Pf at Dorm. Rm ℄ (Cont'd)

Ground Contribution - Recap.

Detector Floor - 5th = .082800
Floor Above 6th = .000365
Floor Below - 4th = .006360
Total = .089525

Above assumes complete fictitious bldg of uniform perimeter.
Now apply azimuth angle fraction

Az ① Contribution = .0895 x .144 (p3) = .0129
Az ② " = .0895 x .222 x .54 = .0107
(B_i(X_i))
Az ③ " = 0

Total Ground Contrib. = .02360
" Roof Contrib = .00031
Total Rf .02391

Protection Factor $= \frac{1}{R_f} = \frac{1}{.02391} = \underline{\underline{42}}$ at center of Dormitory Room.

In other words, approximately half of the dormitory room (the half away from the windows) qualifies as a fallout shelter.

The corridor is obviously better, approximately Pf = 110

Prepared By W B Cobb — W. B. Cobb, Registered Fallout Shelter Analyst | Date 7-13-66

Checked By | Date

Form 127

APPENDIX B

EQUATIONS FOR THE TABLES OF EFFECTIVE TEMPERATURES AND HUMIDITY RATIOS AS A FUNCTION OF WET AND DRY-BULB TEMPERATURES

The tables are based on these relationships:

$$ET = \frac{107.5\ (DB-WB) + 62.3\ WB}{62.3 + DB - WB}$$

where:

ET = Effective temperature, °F

DB = Dry-bulb temperature, °F

WB = Wet-bulb temperature, °F

This relationship is limited to low air velocities and is restricted to the temperature range of

$$45°F \leq DB \leq 110°F$$

$$30°F \leq WB \leq 100°F$$

Effective temperatures from these tables have an error of less than 0.5°F as compared to those determined from the ASHRAE Effective Temperature Nomogram (Ref. 12).

To determine the humidity ratio, Dalton's rule and perfect gas mixture relations are applied:

$$W = 0.622 \left[\frac{P_w}{P - P_w}\right]$$

where:

W = Humidity ratio, lbs water/lb dry air

P_w = Partial pressure of water vapor

P = Barometric pressure (sea level assumed)
(P_w and P in consistant units)

The partial pressure of water vapor is determined from the Carrier equation:

$$P_w = P_s - \left[\frac{(P - P_s)(DB - WB)}{2831 - 1.43\ WB}\right]$$

where:

P_s = Saturation pressure of water vapor at wet-bulb temperature WB (P_w, P_s and P in consistant units)

(The original coefficients were 2800 and 1.30)

Accuracy is 0.5% or better for all but the lowest humidity ratios.

APPENDIX C

TEST DATA LOGSHEETS

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
100 Occupants

Test 1 L.S. 1
Date 1-12-66
1-13-66

			Hour (hourly readings)	AVE.
INITIALS OF TECHNICIAN			[illegible]	[illegible]
SHELTER ENERGY INPUTS				
DESIRED	METABOLIC + EQUIPMENT AND LIGHTING LOADS	MBTU/HR	44.7	[illegible]
ACTUAL	POWER METER READING	KWH	[illegible]	10.7
	INPUT (FROM POWER METER)	MBTU/HR	[illegible]	[illegible]
WATER	DESIRED INPUT	LB/HR	[illegible]	
	ACTUAL INPUT	LB/HR	[illegible]	255
	ENTHALPY	BTU/LB	40	40
	INPUT	MBTU/HR	[illegible]	[illegible]
TOTAL SHELTER ENERGY INPUT		MBTU/HR	[illegible]	[illegible]
TEMPERATURES	PSYCHROMETERS (RESISTANCE BULBS)			
	C1 CORRIDOR NORTH DBT	F	[illegible]	
	C2 CORRIDOR NORTH WBT	F	[illegible]	
	C3 CORRIDOR SOUTH DBT	F	[illegible]	
	C4 CORRIDOR SOUTH WBT	F	[illegible]	
	C5 CORRIDOR CENTER DBT	F	[illegible]	
	C6 CORRIDOR CENTER WBT	F	[illegible]	
	C7 AMBIENT DBT - NORTH WALL OF WEST WING	F	[illegible]	
	C8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
	C9 AMBIENT DBT - SOUTH WALL OF WEST WING	F	[illegible]	
	C10 AMBIENT WBT SOUTH WALL OF WEST WING	F	[illegible]	
	PSYCHROMETERS (MERCURY BULB THERMOMETERS)			
	G1 CORRIDOR NORTH DBT	F	[illegible]	
	G2 CORRIDOR NORTH WBT	F	[illegible]	
	G3 CORRIDOR - CENTER DBT	F	[illegible]	
	G4 CORRIDOR CENTER WBT	F	[illegible]	
	G5 CORRIDOR SOUTH DBT	F	[illegible]	
	G6 CORRIDOR SOUTH WBT	F	[illegible]	
	G7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]	
	G8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
AVERAGES				
AMBIENT	DRY BULB TEMPERATURE	F	[illegible]	[illegible]
	WET BULB TEMPERATURE	F	[illegible]	[illegible]
	EFFECTIVE TEMPERATURE	F	[illegible]	[illegible]
	SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
	HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
SHELTER	DRY BULB TEMPERATURE	F	[illegible]	[illegible]
	WET BULB TEMPERATURE	F	[illegible]	[illegible]
	EFFECTIVE TEMPERATURE	F	[illegible]	[illegible]
	SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
	HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
WIND				
WEATHER BUREAU	WIND VELOCITY	MPH	[illegible]	[illegible]
	WIND DIRECTION		[illegible]	
ROOF	COUNTER READING, R	10^6 COUNTS	[illegible]	[illegible]
	WIND VELOCITY (0.5 + 6.75 × R)	MPH	[illegible]	[illegible]
	WIND DIRECTION		[illegible]	
	WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	[illegible]	
AIR FLOW RATE		CFM	[illegible]	[illegible]
NUMBER OF WINDOWS ACTING AS INLETS	EAST WINDOWS		[illegible]	
	NW WINDOWS		[illegible]	
	SW WINDOWS		[illegible]	
EFFECTIVENESS FACTOR (For F = 1.0)			[illegible]	
COMMENTS	LOG BOOK REFERENCE	PAGE		
	SUBJECT			

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
100 Occupants

Test 1 LS 2
Date 7/16/66 7/17/66

Item	Units	Hourly readings (HOUR)	AVE
INITIALS OF TECHNICIAN		[illegible]	
SHELTER ENERGY INPUTS			
DESIRED — METABOLIC + EQUIPMENT AND LIGHTING LOADS	MBTU/HR	447	457
ACTUAL — POWER METER READING	KWH	[illegible]	169
INPUT (FROM POWER METER)	MBTU/HR	[illegible]	420
WATER — DESIRED INPUT	LB/HR	[illegible]	
ACTUAL INPUT	LB/HR	[illegible]	235
ENTHALPY	BTU/LB	40	460
INPUT	MBTU/HR	[illegible]	0.9
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible]	429
TEMPERATURES — PSYCHROMETERS (RESISTANCE BULBS)			
C1 CORRIDOR NORTH DBT	°F	[illegible]	
C2 CORRIDOR NORTH WBT	°F	[illegible]	
C3 CORRIDOR SOUTH DBT	°F	[illegible]	
C4 CORRIDOR SOUTH WBT	°F	[illegible]	
C5 CORRIDOR CENTER DBT	°F	[illegible]	
C6 CORRIDOR CENTER WBT	°F	[illegible]	
C7 AMBIENT DBT NORTH WALL OF WEST WING	°F	[illegible]	
C8 AMBIENT WBT NORTH WALL OF WEST WING	°F	[illegible]	
C9 AMBIENT DBT SOUTH WALL OF WEST WING	°F	[illegible]	
C10 AMBIENT WBT SOUTH WALL OF WEST WING	°F	[illegible]	
PSYCHROMETERS (MERCURY BULB THERMOMETERS)			
G1 CORRIDOR NORTH DBT	°F	[illegible]	
G2 CORRIDOR NORTH WBT	°F	[illegible]	
G3 CORRIDOR - CENTER DBT	°F	[illegible]	
G4 CORRIDOR CENTER WBT	°F	[illegible]	
G5 CORRIDOR - SOUTH DBT	°F	[illegible]	
G6 CORRIDOR - SOUTH WBT	°F	[illegible]	
G7 AMBIENT DBT NORTH WALL OF WEST WING	°F	[illegible]	
G8 AMBIENT WBT - NORTH WALL OF WEST WING	°F	[illegible]	
AVERAGES			
AMBIENT — DRY BULB TEMPERATURE	°F	[illegible]	76.0
WET BULB TEMPERATURE	°F	[illegible]	69.5
EFFECTIVE TEMPERATURE	°F	[illegible]	73.0
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	13.9
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	.0137
SHELTER — DRY BULB TEMPERATURE	°F	[illegible]	86.0
WET BULB TEMPERATURE	°F	[illegible]	78.0
EFFECTIVE TEMPERATURE	°F	[illegible]	79.4
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	.01536
WIND			
WEATHER BUREAU — WIND VELOCITY	MPH	[illegible]	11.1
WIND DIRECTION		[illegible]	
ROOF — COUNTER READING R	# COUNTS	[illegible]	[illegible]
WIND VELOCITY (R 5 + 0.75 × R)	MPH	[illegible]	7.3
WIND DIRECTION		[illegible]	
WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	[illegible]	
AIR FLOW RATE	CFM	[illegible]	3780
NUMBER OF WINDOWS ACTING AS INLETS — EAST WINDOWS		[illegible]	
NW WINDOWS		[illegible]	
SW WINDOWS		[illegible]	
EFFECTIVENESS FACTOR (See Fig. 8)		[illegible]	
COMMENTS — LOG BOOK REFERENCE	PAGE		
SUBJECT			

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
100 Occupants

Test 2 LS 2
Date 7-14-66 7-15-66

	Units	Hour (hourly readings)	AVE
INITIALS OF TECHNITION		[illegible]	
SHELTER ENERGY INPUTS			
DESIRED — METABOLIC + EQUIPMENT AND LIGHTING LOADS	MBTU/HR	447	447
ACTUAL — POWER METER READING	KWH	[illegible]	[illegible]
INPUT (FROM POWER METER)	MBTU/HR	[illegible]	[illegible]
WATER — DESIRED INPUT	LB/HR	[illegible]	
ACTUAL INPUT	LB/HR	[illegible]	[illegible]
ENTHALPY	BTU/LB	[illegible]	[illegible]
INPUT	MBTU/HR	[illegible]	[illegible]
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible]	[illegible]
TEMPERATURES — PSYCHROMETERS (RESISTANCE BULBS)			
C1 CORRIDOR NORTH DBT	F	[illegible]	
C2 CORRIDOR NORTH WBT	F	[illegible]	
C3 CORRIDOR SOUTH DBT	F	[illegible]	
C4 CORRIDOR SOUTH WBT	F	[illegible]	
C5 CORRIDOR - CENTER DBT	F	[illegible]	
C6 CORRIDOR - CENTER WBT	F	[illegible]	
C7 AMBIENT DBT NORTH WALL OF WEST WING	°F	[illegible]	
C8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
C9 AMBIENT DBT SOUTH WALL OF WEST WING	F	[illegible]	
C10 AMBIENT WBT SOUTH WALL OF WEST WING	°F	[illegible]	
PSYCHROMETERS (MERCURY BULB THERMOMETERS)			
G1 CORRIDOR - NORTH DBT	°F	[illegible]	
G2 CORRIDOR - NORTH WBT	°F	[illegible]	
G3 CORRIDOR - CENTER DBT	F	[illegible]	
G4 CORRIDOR - CENTER WBT	F	[illegible]	
G5 CORRIDOR - SOUTH DBT	F	[illegible]	
G6 CORRIDOR - SOUTH WBT	°F	[illegible]	
G7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]	
G8 AMBIENT WBT NORTH WALL OF WEST WING	°F	[illegible]	
AVERAGES			
AMBIENT — DRY BULB TEMPERATURE	°F	[illegible]	[illegible]
WET BULB TEMPERATURE	F	[illegible]	[illegible]
EFFECTIVE TEMPERATURE	F	[illegible]	[illegible]
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
SHELTER — DRY BULB TEMPERATURE	°F	[illegible]	[illegible]
WET BULB TEMPERATURE	°F	[illegible]	[illegible]
EFFECTIVE TEMPERATURE	°F	[illegible]	[illegible]
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
WIND			
WEATHER BUREAU — WIND VELOCITY	MPH	[illegible]	[illegible]
WIND DIRECTION		[illegible]	
ROOF — COUNTER READING R	10^4 COUNTS	[illegible]	[illegible]
WIND VELOCITY (0.9 + 0.75 x R)	MPH	[illegible]	[illegible]
WIND DIRECTION		[illegible]	
WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	[illegible]	
AIR FLOW RATE	CFM	[illegible]	[illegible]
NUMBER OF WINDOWS ACTING AS INLETS — EAST WINDOWS		[illegible]	
NW WINDOWS		[illegible]	
SW WINDOWS		[illegible]	
EFFECTIVENESS FACTOR (For Ref. 8)		[illegible]	
COMMENTS — LOG BOOK REFERENCE / SUBJECT	PAGE		

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
100 Occupants

Test 3 LD 4
Date [illegible]

		Units	Hourly readings
INITIALS OF TECHNITION			[illegible]
SHELTER ENERGY INPUTS			
DESIRED	METABOLIC + EQUIPMENT AND LIGHTING LOADS	MBTU/HR	[illegible]
ACTUAL	POWER METER READING	KWH	[illegible]
	INPUT (FROM POWER METER)	MBTU/HR	[illegible]
WATER	DESIRED INPUT	LB/HR	[illegible]
	ACTUAL INPUT	LB/HR	[illegible]
	ENTHALPY	BTU/LB	[illegible]
	INPUT	MBTU/HR	[illegible]
TOTAL SHELTER ENERGY INPUT		MBTU/HR	[illegible]
TEMPERATURES	PSYCHROMETERS (RESISTANCE BULBS)		
	C1 CORRIDOR - NORTH DBT	F	[illegible]
	C2 CORRIDOR NORTH WBT	F	[illegible]
	C3 CORRIDOR SOUTH DBT	F	[illegible]
	C4 CORRIDOR - SOUTH WBT	F	[illegible]
	C5 CORRIDOR CENTER DBT	°F	[illegible]
	C6 CORRIDOR CENTER WBT	°F	[illegible]
	C7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]
	C8 AMBIENT WBT NORTH WALL OF WEST WING	°F	[illegible]
	C9 AMBIENT DBT SOUTH WALL OF WEST WING	F	[illegible]
	C10 AMBIENT WBT SOUTH WALL OF WEST WING	F	[illegible]
	PSYCHROMETERS (MERCURY BULB THERMOMETERS)		
	G1 CORRIDOR - NORTH DBT	F	[illegible]
	G2 CORRIDOR - NORTH WBT	°F	[illegible]
	G3 CORRIDOR - CENTER DBT	F	[illegible]
	G4 CORRIDOR CENTER WBT	F	[illegible]
	G5 CORRIDOR SOUTH DBT	F	[illegible]
	G6 CORRIDOR SOUTH WBT	°F	[illegible]
	G7 AMBIENT DBT NORTH WALL OF WEST WING	°F	[illegible]
	G8 AMBIENT WBT - NORTH WALL OF WEST WING	°F	[illegible]
AVERAGES			
AMBIENT	DRY BULB TEMPERATURE	°F	[illegible]
	WET BULB TEMPERATURE	°F	[illegible]
	EFFECTIVE TEMPERATURE	F	[illegible]
	SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]
	HUMIDITY RATIO	LB_w/LB_{da}	[illegible]
SHELTER	DRY BULB TEMPERATURE	°F	[illegible]
	WET BULB TEMPERATURE	°F	[illegible]
	EFFECTIVE TEMPERATURE	F	[illegible]
	SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]
	HUMIDITY RATIO	LB_w/LB_{da}	[illegible]
WIND			
WEATHER BUREAU	WIND VELOCITY	MPH	[illegible]
	WIND DIRECTION		[illegible]
ROOF	COUNTER READING, R	10^3 COUNTS	[illegible]
	WIND VELOCITY (0.5 + 0.75 x R)	MPH	[illegible]
	WIND DIRECTION		[illegible]
	WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	[illegible]
AIR FLOW RATE		CFM	[illegible]
NUMBER OF WINDOWS ACTING AS INLETS	EAST WINDOWS		[illegible]
	NW WINDOWS		[illegible]
	SW WINDOWS		[illegible]
EFFECTIVENESS FACTOR	(Ref. Fe. 8)		[illegible]
COMMENTS	LOG BOOK REFERENCE	PAGE	
	SUBJECT		

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
100 Occupants

Test 3 LS 5
Date [illegible]

		Hourly readings	AVG
INITIALS OF TECHNICIAN		[illegible]	
SHELTER ENERGY INPUTS			
DESIRED — METABOLIC + EQUIPMENT AND LIGHTING LOADS	MBTU/HR	[illegible]	447
ACTUAL — POWER METER READING	KWH	[illegible]	113
INPUT (FROM POWER METER)	MBTU/HR	[illegible]	433
WATER — DESIRED INPUT	LB/HR	[illegible]	
ACTUAL INPUT	LB/HR	[illegible]	254
ENTHALPY	BTU/LB	[illegible]	40.6
INPUT	MBTU/HR	[illegible]	[illegible]
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible]	443
TEMPERATURES — PSYCHROMETERS (RESISTANCE BULBS)			
C1 CORRIDOR NORTH DBT	°F	[illegible]	
C2 CORRIDOR NORTH WBT	°F	[illegible]	
C3 CORRIDOR SOUTH DBT	°F	[illegible]	
C4 CORRIDOR SOUTH WBT	°F	[illegible]	
C5 CORRIDOR CENTER DBT	°F	[illegible]	
C6 CORRIDOR - CENTER WBT	°F	[illegible]	
C7 AMBIENT DBT NORTH WALL OF WEST WING	°F	[illegible]	
C8 AMBIENT WBT NORTH WALL OF WEST WING	°F	[illegible]	
C9 AMBIENT DBT SOUTH WALL OF WEST WING	°F	[illegible]	
C10 AMBIENT WBT - SOUTH WALL OF WEST WING	°F	[illegible]	
PSYCHROMETERS (MERCURY BULB THERMOMETERS)			
G1 CORRIDOR NORTH DBT	°F	[illegible]	
G2 CORRIDOR NORTH WBT	°F	[illegible]	
G3 CORRIDOR CENTER DBT	°F	[illegible]	
G4 CORRIDOR CENTER WBT	°F	[illegible]	
G5 CORRIDOR SOUTH DBT	°F	[illegible]	
G6 CORRIDOR SOUTH WBT	°F	[illegible]	
G7 AMBIENT DBT NORTH WALL OF WEST WING	°F	[illegible]	
G8 AMBIENT WBT - NORTH WALL OF WEST WING	°F	[illegible]	
AVERAGES			
AMBIENT — DRY BULB TEMPERATURE	°F	[illegible]	85.5
WET BULB TEMPERATURE	°F	[illegible]	71.5
EFFECTIVE TEMPERATURE	°F	[illegible]	71.9
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	14.1
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
SHELTER — DRY BULB TEMPERATURE	°F	[illegible]	87.0
WET BULB TEMPERATURE	°F	[illegible]	75.0
EFFECTIVE TEMPERATURE	°F	[illegible]	80.2
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	14.1
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	.01573
WIND			
WEATHER BUREAU — WIND VELOCITY	MPH	[illegible]	12.2
WIND DIRECTION		[illegible]	
ROOF — COUNTER READING	# COUNTS	[illegible]	1280
WIND VELOCITY	MPH	[illegible]	11.7
WIND DIRECTION		[illegible]	—
WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	[illegible]	—
AIR FLOW RATE	CFM	[illegible]	8510
NUMBER OF WINDOWS ACTING AS INLETS — EAST WINDOWS		[illegible]	
NW WINDOWS		[illegible]	
SW WINDOWS		[illegible]	
EFFECTIVENESS FACTOR		[illegible]	
COMMENTS — LOG BOOK REFERENCE, SUBJECT	PAGE	12	

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
[illegible] Occupants

Test 3-4 L.S. 6
Date [illegible]

Test #3 | Test #4

	Units	Hourly readings	AVE
INITIALS OF TECHNICIAN		[illegible]	
SHELTER ENERGY INPUTS			
DESIRED — METABOLIC + EQUIPMENT AND LIGHTING LOADS	MBTU/HR	[illegible]	[illegible]
ACTUAL — POWER METER READING	KWH	[illegible]	[illegible]
INPUT (FROM POWER METER)	MBTU/HR	[illegible]	[illegible]
WATER — DESIRED INPUT	LB/HR	[illegible]	
ACTUAL INPUT	LB/HR	[illegible]	[illegible]
ENTHALPY	BTU/LB	[illegible]	[illegible]
INPUT	MBTU/HR	[illegible]	[illegible]
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible]	[illegible]
TEMPERATURES — PSYCHROMETERS (RESISTANCE BULBS)			
C1 CORRIDOR NORTH DBT	°F	[illegible]	
C2 CORRIDOR NORTH WBT	°F	[illegible]	
C3 CORRIDOR SOUTH DBT	°F	[illegible]	
C4 CORRIDOR SOUTH WBT	°F	[illegible]	
C5 CORRIDOR CENTER DBT	°F	[illegible]	
C6 CORRIDOR CENTER WBT	°F	[illegible]	
C7 AMBIENT DBT NORTH WALL OF WEST WING	°F	[illegible]	
C8 AMBIENT WBT NORTH WALL OF WEST WING	°F	[illegible]	
C9 AMBIENT DBT SOUTH WALL OF WEST WING	°F	[illegible]	
C10 AMBIENT WBT SOUTH WALL OF WEST WING	°F	[illegible]	
PSYCHROMETERS (MERCURY IN GLASS THERMOMETERS)			
G1 CORRIDOR NORTH DBT	°F	[illegible]	
G2 CORRIDOR NORTH WBT	°F	[illegible]	
G3 CORRIDOR - CENTER DBT	°F	[illegible]	
G4 CORRIDOR CENTER WBT	°F	[illegible]	
G5 CORRIDOR SOUTH DBT	°F	[illegible]	
G6 CORRIDOR SOUTH WBT	°F	[illegible]	
G7 AMBIENT DBT NORTH WALL OF WEST WING	°F	[illegible]	
G8 AMBIENT WBT NORTH WALL OF WEST WING	°F	[illegible]	
AVERAGES — AMBIENT — DRY BULB TEMPERATURE	°F	[illegible]	[illegible]
WET BULB TEMPERATURE	°F	[illegible]	[illegible]
EFFECTIVE TEMPERATURE	°F	[illegible]	[illegible]
SPECIFIC VOLUME	FT³/LB	[illegible]	[illegible]
HUMIDITY RATIO	LB/LB	[illegible]	[illegible]
SHELTER — DRY BULB TEMPERATURE	°F	[illegible]	[illegible]
WET BULB TEMPERATURE	°F	[illegible]	[illegible]
EFFECTIVE TEMPERATURE	°F	[illegible]	[illegible]
SPECIFIC VOLUME	FT³/LB	[illegible]	[illegible]
HUMIDITY RATIO	LB/LB	[illegible]	[illegible]
WIND — WEATHER BUREAU — WIND VELOCITY	MPH	[illegible]	[illegible]
WIND DIRECTION		[illegible]	
ROOF — COUNTER READING	COUNTS	[illegible]	[illegible]
WIND VELOCITY	MPH	[illegible]	[illegible]
WIND DIRECTION		[illegible]	
WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	[illegible]	
AIR FLOW RATE	CFM	[illegible]	[illegible]
NUMBER OF WINDOWS ACTING AS INLETS — EAST WINDOWS		[illegible]	
NE WINDOWS		[illegible]	
SW WINDOWS		[illegible]	
EFFECTIVENESS FACTOR		[illegible]	
COMMENTS — LOG BOOK REFERENCE SUBJECT	PAGE	19	

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
115 Occupants

Test # [illegible] 7
Date [illegible]

			AVE
INITIALS OF TECHNICIAN		[illegible]	
SHELTER ENERGY INPUTS			
DESIRED METABOLIC + EQUIPMENT AND LIGHTING LOADS	MBTU/HR	[illegible]	735
ACTUAL POWER METER READING	KWH	[illegible]	[illegible]
INPUT (FROM POWER METER)	MBTU/HR	[illegible]	[illegible]
WATER DESIRED INPUT	LB/HR	[illegible]	
ACTUAL INPUT	LB/HR	[illegible]	[illegible]
ENTHALPY	BTU/LB	[illegible]	[illegible]
INPUT	MBTU/HR	[illegible]	[illegible]
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible]	[illegible]
TEMPERATURES PSYCHROMETERS (RESIS. TC BULBS)			
C1 CORRIDOR NORTH DBT	°F	[illegible]	
C2 CORRIDOR NORTH WBT	°F	[illegible]	
C3 CORRIDOR SOUTH DBT	°F	[illegible]	
C4 CORRIDOR - SOUTH WBT	°F	[illegible]	
C5 CORRIDOR CENTER DBT	°F	[illegible]	
C6 CORRIDOR CENTER WBT	°F	[illegible]	
C7 AMBIENT DBT - NORTH WALL OF WEST WING	°F	[illegible]	
C8 AMBIENT WBT NORTH WALL OF WEST WING	°F	[illegible]	
C9 AMBIENT DBT SOUTH WALL OF WEST WING	°F	[illegible]	
C10 AMBIENT WBT SOUTH WALL OF WEST WING	°F	[illegible]	
PSYCHROMETERS (MERCURY BULB THERMOMETERS)			
G1 CORRIDOR NORTH DBT	°F	[illegible]	
G2 CORRIDOR - NORTH WBT	°F	[illegible]	
G3 CORRIDOR CENTER DBT	°F	[illegible]	
G4 CORRIDOR CENTER WBT	°F	[illegible]	
G5 CORRIDOR SOUTH DBT	°F	[illegible]	
G6 CORRIDOR SOUTH WBT	°F	[illegible]	
G7 AMBIENT DBT NORTH WALL OF WEST WING	°F	[illegible]	
G8 AMBIENT WBT NORTH WALL OF WEST WING	°F	[illegible]	
AVERAGES			
AMBIENT DRY BULB TEMPERATURE	°F	[illegible]	745
WET BULB TEMPERATURE	°F	[illegible]	645
EFFECTIVE TEMPERATURE	°F	[illegible]	[illegible]
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
SHELTER DRY BULB TEMPERATURE	°F	[illegible]	[illegible]
WET BULB TEMPERATURE	°F	[illegible]	[illegible]
EFFECTIVE TEMPERATURE	°F	[illegible]	[illegible]
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
WIND			
WEATHER BUREAU WIND VELOCITY	MPH	[illegible]	[illegible]
WIND DIRECTION		[illegible]	E
ROOF COUNTER READING R	10^3 COUNTS	[illegible]	[illegible]
WIND VELOCITY	MPH	[illegible]	[illegible]
WIND DIRECTION		[illegible]	
WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	[illegible]	
AIR FLOW RATE	CFM	[illegible]	[illegible]
NUMBER OF WINDOWS ACTING AS INLETS — EAST WINDOWS		[illegible]	
SW WINDOWS		[illegible]	
SW WINDOWS		[illegible]	
EFFECTIVENESS FACTOR		[illegible]	
COMMENTS — LOG BOOK REFERENCE	PAGE		

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
185 Occupants

Test 4 LS 8
Date 7-21-66

Items of Technique		Units	0800	0900	1000	1100	Ave
SHELTER ENERGY INPUTS							
DESIRED	METABOLIC + EQUIPMENT AND LIGHTING LOADS	MBTU/HR	785 →				785
ACTUAL	POWER METER READING	KWH	1260	1413	1239	1039	214
	INPUT (FROM POWER METER)	MBTU/HR	717	774	795	760	727
WATER	DESIRED INPUT	LB/HR	355	393	388	407	
	ACTUAL INPUT	LB/HR	355	395	390	395	395
	ENTHALPY	BTU/LB	40 →				40
	INPUT	MBTU/HR	16	16	16	16	16
TOTAL SHELTER ENERGY INPUT		MBTU/HR	803	790	801	776	79 3
TEMPERATURES	PSYCHROMETERS (RESISTANCE BULBS)						
	C1 CORRIDOR NORTH DBT	F	805	810	815	815	
	C2 CORRIDOR NORTH WBT	F	650	670	680	660	
	C3 CORRIDOR SOUTH DBT	F	850	845	840	850	
	C4 CORRIDOR SOUTH WBT	F	735	735	720	720	
	C5 CORRIDOR CENTER DBT	F	860	862	865	870	
	C6 CORRIDOR CENTER WBT	F	745	740	695	680	
	C7 AMBIENT DBT NORTH WALL OF WEST WING	F	745	720	740	755	
	C8 AMBIENT WBT NORTH WALL OF WEST WING	F	660	660	660	660	
	C9 AMBIENT DBT SOUTH WALL OF WEST WING	F	745	745	750	795	
	C10 AMBIENT WBT SOUTH WALL OF WEST WING	F	630	645	685	655	
	PSYCHROMETERS (MERCURY BULB THERMOMETERS)						
	G1 CORRIDOR NORTH DBT	F	820	820	820	815	
	G2 CORRIDOR NORTH WBT	F	685	680	675	660	
	G3 CORRIDOR CENTER DBT	F	805	855	840	880	
	G4 CORRIDOR CENTER WBT	F	715	690	695	690	
	G5 CORRIDOR SOUTH DBT	F	860	855	880	875	
	G6 CORRIDOR SOUTH WBT	F	720	720	725	700	
	G7 AMBIENT DBT NORTH WALL OF WEST WING	F	770	770	795	755	
	G8 AMBIENT WBT NORTH WALL OF WEST WING	F	600	595	595	590	
AVERAGES							
AMBIENT	DRY BULB TEMPERATURE	F	765	730	785	778	740
	WET BULB TEMPERATURE	F	665	620	630	636	626
	EFFECTIVE TEMPERATURE	F	678	658	686	703	692
	SPECIFIC VOLUME	FT^3/LB_{da}	13.6	13.6	13.7	13.7	13.7
	HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SHELTER	DRY BULB TEMPERATURE	F	845	845	845	850	845
	WET BULB TEMPERATURE	F	705	700	685	695	695
	EFFECTIVE TEMPERATURE	F	773	770	768	766	768
	SPECIFIC VOLUME	FT^3/LB_{da}	14.0	14.0	14.0	14.0	14.0
	HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
WIND							
WEATHER BUREAU	WIND VELOCITY	MPH	6.9	7.5	9.2	8.9	80
	WIND DIRECTION		E	ENE	E	SE	
ROOF	COUNTER READING	COUNTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	VELOCITY	MPH	5.2	5.7	5.9	6.8	56
	DIRECTION		NE	ENE	ENE	ENE	
	VELOCITY (TAYLOR WINDSCOPE)	MPH	5	5	4	7	
AIR FLOW RATE		CFM	[illegible]	[illegible]	[illegible]	[illegible]	2150
NUMBER OF WINDOWS OPEN	EAST WINDOWS		12	24	12	12	
	NW WINDOWS		–	–	–	–	
	SW WINDOWS		–	–	–	–	
EFFECTIVENESS			[illegible]				

COMMENTS | LOG BOOK REFERENCE | PAGE

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
185 Occupants

Test 5 LS L
Date 7-31-?

		Units	HOUR (hourly readings)	AVE
INITIALS OF TECHNICIAN			[illegible]	
SHELTER ENERGY INPUTS				
DESIRED	METABOLIC EQUIPMENT AND LIGHTING LOADS	MBTU/HR	785 →	785
ACTUAL	POWER METER READING	KWH	[illegible]	2/4
	INPUT (FROM POWER METER)	MBTU/HR	[illegible]	777
WATER	DESIRED INPUT	LB/HR	[illegible]	
	ACTUAL INPUT	LB/HR	[illegible]	75
	ENTHALPY	BTU/LB	40 →	40
	INPUT	MBTU/HR	[illegible]	
TOTAL SHELTER ENERGY INPUT		MBTU/HR	[illegible]	
TEMPERATURES	PSYCHROMETERS (RESISTANCE BULBS)			
	C1 CORRIDOR NORTH DBT	F	[illegible]	
	C2 CORRIDOR NORTH WBT	F	[illegible]	
	C3 CORRIDOR SOUTH DBT	F	[illegible]	
	C4 CORRIDOR SOUTH WBT	F	[illegible]	
	C5 CORRIDOR CENTER DBT	F	[illegible]	
	C6 CORRIDOR CENTER WBT	F	[illegible]	
	C7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]	
	C8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
	C9 AMBIENT DBT SOUTH WALL OF WEST WING	F	[illegible]	
	C10 AMBIENT WBT SOUTH WALL OF WEST WING	F	[illegible]	
	PSYCHROMETERS (MERCURY BULB THERMOMETERS)			
	G1 CORRIDOR NORTH DBT	F	[illegible]	
	G2 CORRIDOR NORTH WBT	F	[illegible]	
	G3 CORRIDOR CENTER DBT	F	[illegible]	
	G4 CORRIDOR CENTER WBT	F	[illegible]	
	G5 CORRIDOR SOUTH DBT	F	[illegible]	
	G6 CORRIDOR SOUTH WBT	F	[illegible]	
	G7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]	
	G8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
AVERAGES				
AMBIENT	DRY BULB TEMPERATURE	F	[illegible]	725
	WET BULB TEMPERATURE	F	[illegible]	620
	EFFECTIVE TEMPERATURE	F	[illegible]	[illegible]
	SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	136
	HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
SHELTER	DRY BULB TEMPERATURE	F	[illegible]	825
	WET BULB TEMPERATURE	F	[illegible]	680
	EFFECTIVE TEMPERATURE	F	[illegible]	758
	SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	139
	HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
WIND				
WEATHER BUREAU	WIND VELOCITY	MPH	[illegible]	70
	WIND DIRECTION		[illegible]	
ROOF	COUNTER READING R	10² COUNTS	[illegible]	0 527
	WIND VELOCITY	MPH	[illegible]	51
	WIND DIRECTION		[illegible]	
	WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	[illegible]	
AIR FLOW RATE		CFM	[illegible]	5410
NUMBER OF WINDOWS ACTING AS INLETS	EAST WINDOWS		[illegible]	
	NW WINDOWS		[illegible]	
	SW WINDOWS		[illegible]	
EFFECTIVENESS			[illegible]	

COMMENTS

LOG BOOK REFERENCE
SUBJECT

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Urbana, Illinois

Natural Ventilation Test
185 Occupants

Test 5 … 5 16
Date [illegible]

Item	Units	Hourly readings (HO)	AVE
SHELTER ENERGY INPUTS — DESIRED: METABOLIC, EQUIPMENT AND LIGHTING LOADS	MBTU/HR	735 →	735
ACTUAL: POWER METER READING	KWH	[illegible]	212
INPUT (FROM POWER METER)	MBTU/HR	[illegible]	[illegible]
WATER: DESIRED INPUT	LB/HR	[illegible]	[illegible]
ACTUAL INPUT	LB/HR	[illegible]	400
ENTHALPY	BTU/LB	40 →	400
INPUT	MBTU/HR	15 16 16 16 17 16 16 16 16 16 [illegible]	16
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible]	786
TEMPERATURES — PSYCHROMETERS (RESISTANCE BULBS): C1 CORRIDOR NORTH DBT	F	[illegible]	
C2 CORRIDOR NORTH WBT	F	[illegible]	
C3 CORRIDOR SOUTH DBT	F	[illegible]	
C4 CORRIDOR SOUTH WBT	F	[illegible]	
C5 CORRIDOR CENTER DBT	F	[illegible]	
C6 CORRIDOR CENTER WBT	F	[illegible]	
C7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]	
C8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
C9 AMBIENT DBT SOUTH WALL OF WEST WING	F	[illegible]	
C10 AMBIENT WBT SOUTH WALL OF WEST WING	F	[illegible]	
PSYCHROMETERS (MERCURY BULB THERMOMETERS): G1 CORRIDOR NORTH DBT	F	[illegible]	
G2 CORRIDOR NORTH WBT	F	[illegible]	
G3 CORRIDOR CENTER DBT	F	[illegible]	
G4 CORRIDOR CENTER WBT	F	[illegible]	
G5 CORRIDOR SOUTH DBT	F	[illegible]	
G6 CORRIDOR SOUTH WBT	F	[illegible]	
G7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]	
G8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
AVERAGES — AMBIENT: DB TEMPERATURE	F	[illegible]	785
WB TEMPERATURE	F	[illegible]	660
EFFECTIVE TEMPERATURE	F	[illegible]	727
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	138
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
SHELTER: DRY BULB TEMPERATURE	F	[illegible]	850
WET BULB TEMPERATURE	F	[illegible]	700
EFFECTIVE TEMPERATURE	F	[illegible]	772
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	140
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	0127
WIND — WEATHER BUREAU: WIND VELOCITY	MPH	61 115 115 115 92 92 35 23 35 58 92 115 58 69 58 58 58 46 58 81 92 92 92 92	7.6
WIND DIRECTION		WSW WSW SW SW S SW SW SW SE ESE S S S S SE S S SW SW WSW WSW WSW SW NW	
ROOF: COUNTER READING	COUNTS	[illegible]	0.621
WIND VELOCITY	MPH	66 75 72 83 72 57 46 37 43 38 [illegible] 86 73 [illegible] 61 59 44 [illegible] 47 69 [illegible] 56 46	59
WIND DIRECTION		SW SSW S S S S ENE E ENE ENE E S [illegible] S SSE S S S SW [illegible]	
WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	7 10 7 6 7.5 2 0 3 3 10 2 10 6 7 9 5 Calm 6 6 11 6 6 7	—
AIR FLOW RATE	CFM	[illegible]	6030
NUMBER OF WINDOWS ACTING AS INLETS: EAST WINDOWS		— — — — — 12 12 12 12 [illegible] 24 24 24 24 24 — — — — — — —	
NW WINDOWS		[illegible] 10	
SW WINDOWS		7 7 7 7 7 [illegible]	
EFFECTIVENESS FACTOR		[illegible]	
COMMENTS — LOG BOOK REFERENCE; SUBJECT	PAGE		

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
185 Occupants

Test 6 ... 11

Date [illegible]

			AVE
INITIALS OF TECHNICIAN		[illegible]	JL
SHELTER ENERGY INPUTS			
DESIRED — METABOLIC + EQUIPMENT AND LIGHTING LOADS	MBTU/HR	785 →	785
ACTUAL — POWER METER READING	KWH	[illegible]	211
INPUT (FROM POWER METER)	MBTU/HR	[illegible]	767
WATER — DESIRED INPUT	LB/HR	[illegible]	
ACTUAL INPUT	LB/HR	[illegible]	475
ENTHALPY	BTU/LB	40 →	40
INPUT	MBTU/HR	[illegible]	19
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible]	[illegible]
TEMPERATURES — PSYCHROMETERS (RESISTANCE BULBS)			
C1 CORRIDOR NORTH DBT	F	[illegible]	
C2 CORRIDOR NORTH WBT	F	[illegible]	
C3 CORRIDOR SOUTH DBT	F	[illegible]	
C4 CORRIDOR SOUTH WBT	F	[illegible]	
C5 CORRIDOR CENTER DBT	F	[illegible]	
C6 CORRIDOR CENTER WBT	F	[illegible]	
C7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]	
C8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
C9 AMBIENT DBT SOUTH WALL OF WEST WING	F	[illegible]	
C10 AMBIENT WBT SOUTH WALL OF WEST WING	F	[illegible]	
PSYCHROMETERS (MERCURY BULB THERMOMETERS)			
G1 CORRIDOR NORTH DBT	F	[illegible]	
G2 CORRIDOR NORTH WBT	F	[illegible]	
G3 CORRIDOR CENTER DBT	F	[illegible]	
G4 CORRIDOR CENTER WBT	F	[illegible]	
G5 CORRIDOR SOUTH DBT	F	[illegible]	
G6 CORRIDOR SOUTH WBT	F	[illegible]	
G7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]	
G8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
AVERAGES			
AMBIENT — DRY BULB TEMPERATURE	F	[illegible]	850
WET BULB TEMPERATURE	F	[illegible]	785
EFFECTIVE TEMPERATURE	F	[illegible]	792
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
SHELTER — DRY BULB TEMPERATURE	F	[illegible]	890
WET BULB TEMPERATURE	F	[illegible]	805
EFFECTIVE TEMPERATURE	F	[illegible]	837
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
WIND			
WEATHER BUREAU — WIND VELOCITY	MPH	[illegible] 92 15 115 81 [illegible] 150 138 [illegible] 134 115 115 92 92 69 58 58 58 58 58 92 69 46 [illegible]	86
WIND DIRECTION		— S SW WSW SW S S SW SW SSW SW SW SSW SSW W WSW SW S S S SSW SSW SSW —	
ROOF — COUNTER READING	COUNTS	[illegible]	[illegible]
WIND VELOCITY	MPH	45 52 66 72 63 [illegible]	67
WIND DIRECTION		SW SW SSW SSW [illegible] SSW SSW [illegible] SSW SW SW SW SSW WSW WSW SW SW SSW SSW S [illegible]	
WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	5 5 [illegible] 7 9 12 [illegible] 12 7 [illegible] 9 9 9 6 4 2 3 2 1 [illegible]	—
AIR FLOW RATE	CFM	[illegible]	[illegible]
NUMBER OF WINDOWS ACTING AS INLETS — EAST WINDOWS		[illegible]	
NW WINDOWS		[illegible] 2 2 2 2 2 [illegible]	
SW WINDOWS		[illegible] 1 1 1 1 1 1 [illegible]	
EFFECTIVENESS FACTOR		[illegible]	
COMMENTS — LOG BOOK REFERENCE, SUBJECT	PAGE	[illegible]	

University of Illinois
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Urbana, Illinois

Natural Ventilation Test
195 Occupants

Test 6 ― 25 ― 12
Date [illegible]

			AVE
SHELTER ENERGY INPUTS			
DESIRED — Metabolic + Equipment and Lighting Loads	MBTU/HR	[illegible]	785
ACTUAL — Power Meter Reading	KWH	[illegible]	212
Input (from Power Meter)	MBTU/HR	[illegible]	770
WATER — Desired Input	LB/HR	[illegible]	
Actual Input	LB/HR	[illegible]	490
Enthalpy	BTU/LB	[illegible]	40
Input	MBTU/HR	[illegible]	20
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible]	786
TEMPERATURES — Psychrometers Resistance Bulbs			
C1 Corridor North DBT	F	[illegible]	
C2 Corridor North WBT	F	[illegible]	
C3 Corridor South DBT	F	[illegible]	
C4 Corridor South WBT	F	[illegible]	
C5 Corridor Center DBT	F	[illegible]	
C6 Corridor Center WBT	F	[illegible]	
C7 Ambient DBT North Wall of West Wing	F	[illegible]	
C8 Ambient WBT North Wall of West Wing	F	[illegible]	
C9 Ambient DBT South Wall of West Wing	F	[illegible]	
C10 Ambient WBT South Wall of West Wing	F	[illegible]	
Psychrometers Mercury Bulb Thermometers			
G1 Corridor North DB	F	[illegible]	
G2 Corridor North WB	F	[illegible]	
G3 Corridor Center DBT	F	[illegible]	
G4 Corridor Center WBT	F	[illegible]	
G5 Corridor South DBT	F	[illegible]	
G6 Corridor South WBT	F	[illegible]	
G7 Ambient DBT North Wall of West Wing	F	[illegible]	
G8 Ambient WB North Wall of West Wing	F	[illegible]	
AVERAGES — AMBIENT: Dry Bulb Temperature	F	[illegible]	80.5
Wet Bulb Temperature	F	[illegible]	77.0
Effective Temperature	F	[illegible]	77.1
Specific Volume	FT^3/LB_{da}	[illegible]	14.0
Humidity Ratio	LB_w/LB_{da}	[illegible]	.01658
SHELTER — Dry Bulb Temperature	F	[illegible]	89.5
Wet Bulb Temperature	F	[illegible]	81.0
Effective Temperature	F	[illegible]	84.1
Specific Volume	FT^3/LB_{da}	[illegible]	14.3
Humidity Ratio	LB_w/LB_{da}	[illegible]	.01697
WIND — WEATHER BUREAU: Wind Velocity	MPH	[illegible]	9.5
Wind Direction		[illegible]	
ROOF — Counter Reading	10^6 COUNTS	[illegible]	0.832
Wind Velocity	MPH	[illegible]	7.8
Wind Direction		[illegible]	
Air Velocity (Taylor Windscope)	MPH	[illegible]	
AIR FLOW RATE	CFM	[illegible]	2724
Number of Windows Acting as Inlets — East Windows		[illegible]	
NW Windows		[illegible]	
SW Windows		[illegible]	
EFFECTIVENESS FACTOR		[illegible]	

COMMENTS — Log Book Reference — Subject — PAGE 26

University of Illinois
Student Residence Hall
Urbana, Illinois

Natural Ventilation Test
185 Occupants

Test 7
Date 7-27-66

			AVE
SHELTER ENERGY INPUTS			
DESIRED — METABOLIC, EQUIPMENT AND LIGHTING LOADS	MBTU/HR	785→	785
ACTUAL — POWER METER READING	KWH	[illegible]	211
INPUT (FROM POWER METER)	MBTU/HR	[illegible]	[illegible]
WATER — DESIRED INPUT	B/HR	425 407 407 416 425 [illegible] 416 437 446 455 455	
ACTUAL INPUT	LB/HR	[illegible] 445 [illegible] 435	425
ENTHALPY	BTU/LB	40→	40
INPUT	MBTU/HR	17 17 17 17 [illegible] 17 17 17 17 17 17	17
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible] 791 787 791	[illegible]
TEMPERATURES — PSYCHROMETERS (RESISTANCE BULBS)			
C1 CORRIDOR NORTH DBT	F	[illegible] 825 860 865	
C2 CORRIDOR NORTH WBT	F	[illegible] 815 810 810	
C3 CORRIDOR SOUTH DBT	F	[illegible] 845 850 855	
C4 CORRIDOR SOUTH WBT	F	[illegible] 775 775 780	
C5 CORRIDOR CENTER DBT	F	[illegible] 850 845 845	
C6 CORRIDOR CENTER WBT	F	[illegible] 780 790 [illegible]	
C7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible] 825 815 855	
C8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible] 755 760 765	
C9 AMBIENT DBT SOUTH WALL OF WEST WING	F	[illegible]	
C10 AMBIENT WBT SOUTH WALL OF WEST WING	F	[illegible] 760 770 770	
PSYCHROMETERS (MERCURY BULB THERMOMETERS)			
G1 CORRIDOR NORTH DBT	F	[illegible] 870 [illegible] 875	
G2 CORRIDOR NORTH WBT	F	[illegible] 770	
G3 CORRIDOR CENTER DBT	F	[illegible] 900 905 875	
G4 CORRIDOR CENTER WBT	F	[illegible] 790	
G5 CORRIDOR SOUTH DBT	F	[illegible]	
G6 CORRIDOR SOUTH WBT	F	[illegible] 780 [illegible]	
G7 AMBIENT DBT NORTH WALL OF WEST WING	F	[illegible]	
G8 AMBIENT WBT NORTH WALL OF WEST WING	F	[illegible]	
AVERAGES — AMBIENT DRY BULB TEMPERATURE	F	[illegible] 815 [illegible]	770
WET BULB TEMPERATURE	F	[illegible] 755 765 765	740
EFFECTIVE TEMPERATURE	F	[illegible] 763 796 [illegible]	[illegible]
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible]	[illegible]
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
SHELTER — DRY BULB TEMPERATURE	F	[illegible] 870 875 875	[illegible]
WET BULB TEMPERATURE	F	[illegible] 795 795 795	[illegible]
EFFECTIVE TEMPERATURE	F	[illegible]	[illegible]
SPECIFIC VOLUME	FT^3/LB_{da}	[illegible] 142 142 142	[illegible]
HUMIDITY RATIO	LB_w/LB_{da}	[illegible]	[illegible]
WIND — WEATHER BUREAU WIND VELOCITY	MPH	[illegible] 115 42 150	116
WIND DIRECTION		S SSE S S S SSW SSW SSW SW W SW WSW	
ROOF — COUNTER READING, R	10^3 COUNTS	[illegible]	[illegible]
WIND VELOCITY (0.5 + 8.75 x R)	MPH	[illegible] 73 76	70
WIND DIRECTION		S S S S SW SW SW SW SW	
WIND VELOCITY (TAYLOR WINDSCOPE)	MPH	[illegible] 5 6	
AIR FLOW RATE	CFM	[illegible] 5380 [illegible]	4060
NUMBER OF WINDOWS ACTING AS INLETS — EAST WINDOWS		[illegible]	
NW WINDOWS		[illegible]	
SW WINDOWS		[illegible] 2 2 2 2 2 2 [illegible] 2 2	
EFFECTIVENESS FACTOR (E = F. 1.0)		[illegible] 0.29 0.25	

COMMENTS — LOG BOOK REFERENCE — SUBJECT — PAGE

University of Illinois
Student Residence Hall
Chicago Illinois

Natural Ventilation Test
185 Occupants

Test 5 (5 14)
Date 7-21-66

Item	Units	Hourly readings (HOUR)	AVE
SHELTER ENERGY INPUTS			
DESIRED — Metabolic + equipment and lighting loads	MBTU/HR	785 →	785
ACTUAL — Power meter reading	KWH	[illegible]	210
Input (from power meter)	MBTU/HR	[illegible]	764
WATER — Desired input	LB/HR	[illegible]	
Actual input	LB/HR	[illegible]	435
Enthalpy	BTU/LB	40 →	400
Input	MBTU/HR	17 18 17 18 17 18 17 18 18 17 17 16 16 17 17 17	17
TOTAL SHELTER ENERGY INPUT	MBTU/HR	[illegible]	781
TEMPERATURES — Psychrometers (resistance bulbs)			
C1 Corridor north DBT	F	[illegible]	
C2 Corridor north WBT	F	[illegible]	
C3 Corridor south DBT	F	[illegible]	
C4 Corridor south WBT	F	[illegible]	
C5 Corridor center DBT	F	[illegible]	
C6 Corridor center WBT	F	[illegible]	
C7 Ambient DBT north wall of west wing	F	[illegible]	
C8 Ambient WBT north wall of west wing	F	[illegible]	
C9 Ambient DBT south wall of west wing	F	[illegible]	
C10 Ambient WBT south wall of west wing	F	[illegible]	
Psychrometers (mercury bulb thermometers)			
G1 Corridor north DBT	F	[illegible]	
G2 Corridor north WBT	F	[illegible]	
G3 Corridor center DBT	F	[illegible]	
G4 Corridor center WBT	F	[illegible]	
G5 Corridor south DBT	F	[illegible]	
G6 Corridor south WBT	F	[illegible]	
G7 Ambient DBT north wall of west wing	F	[illegible]	
G8 Ambient WBT north wall of west wing	F	[illegible]	
AVERAGES — AMBIENT Dry bulb temperature	F	[illegible]	800
Wet bulb temperature	F	[illegible]	750
Effective temperature	F	[illegible]	774
Specific volume	FT^3/LB_{da}	[illegible]	140
Humidity ratio	LB_w/LB_{da}	[illegible]	[illegible]
SHELTER Dry bulb temperature	F	[illegible]	860
Wet bulb temperature	F	[illegible]	785
Effective temperature	F	[illegible]	816
Specific volume	FT^3/LB_{da}	[illegible]	142
Humidity ratio	LB_w/LB_{da}	[illegible]	[illegible]
WIND — WEATHER BUREAU Wind velocity	MPH	104 61 46 58 58 58 46 69 69 58 58 35 46 58 58 92	61
Wind direction		[illegible]	
ROOF Counter reading	10^4 COUNTS	[illegible]	[illegible]
Wind velocity	MPH	[illegible]	54
Wind direction		[illegible]	
Wind velocity (Taylor windscope)	MPH	[illegible]	
AIR FLOW RATE	CFM	[illegible]	5080
NUMBER OF WINDOWS ACTING AS INLETS — East windows		5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	
NW windows		4 4 4 4 4 4 4 4 4 4 4 4 4 4	
SW windows			
EFFECTIVENESS FACTOR		[illegible]	
COMMENTS — Log book reference / Subject	PAGE	23	

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13 ABSTRACT

The results are reported on a natural ventilation test of a corridor-type shelter located in Chicago. The effective temperature of this shelter when occupied at a density of 10 square feet per person will not exceed 33°F for more than seven days during an average year. This interim report describes environmental tests performed in a specific shelter. The discussion of the results is preliminary and should not be used as the basis for general conclusions. A subsequent final report will include a comparative evaluation of data from subsequent tests having a variety of configurations and locations.

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Natural Ventilation Test of an Aboveground Fallout Shelter in Chicago, Illinois
OCD Work Unit 1214A
Interim Report 1268-81
By R. H. Henninger and C. A. Madson
August 1966 (UNCLASSIFIED), pp. 81

The results are reported on a natural ventilation test of a corridor-type shelter located in Chicago. The effective temperature of this shelter when occupied at a density of 10 square feet per person will not exceed 83°F for more than seven days during an average year. This interim report describes environmental tests performed in a specific shelter. The discussion of the results is preliminary and should not be used as the basis for general conclusions. A subsequent final report will include a comparative evaluation of data from subsequent tests having a variety of configurations and locations.

CIVIL DEFENSE SYSTEMS, FALLOUT SHELTERS, TESTS, WIND, TEMPERATURE, HUMIDITY, VENTILATION

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